# SMPTE

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# An Aspheric Lens for Motion-Picture Projection

By R. E. HARRINGTON

**An aspheric lens is described which is designed to be added to the elliptical mirror-type projection optical system commonly used with carbon-arc light sources. The aspheric lens is designed to reduce the effects of the inherent foreshortening of those crater images formed by the outer zones of an elliptical mirror of large collection angle. Measurements using a sample aspheric lens with an f/2.25 mirror showed an increased uniformity of both screen color and brightness distribution at the expense of a reduction in light on the screen. The addition of the lens substantially reduced the variations in screen color that accompany changes in crater position. The aspheric lens can be combined with a faster mirror to give the same screen light as with a slower mirror alone, but with an improved color and brightness distribution.**

THE ELLIPTICAL MIRROR optical system used so widely in the projection of 35mm motion pictures gives acceptable color and brightness uniformity across the screen. However, the present trend is toward systems using faster mirrors and projection lenses, and this tends to reduce the color and brightness uniformity unless either a larger carbon or a modification of the optical system is used. An aspheric lens has been designed which can be combined with the standard mirror system to improve color and brightness uniformity in cases where this becomes desirable.

Jones[1] has given a detailed description of the formation of an enlarged image of a carbon crater by an elliptical mirror. Only the center (or axis) of the mirror produces a circular image of a circularly shaped light source. Each off-axis element of the mirror produces an elliptically shaped image of the crater. The size, shape and orientation of the images are determined by the exact mirror area forming the image.

Figure 1A illustrates the behavior of the familiar elliptical mirror used with lamps operating with "Suprex" carbons. This mirror has a collection angle of 145° and a nominal axial magnification of 6.6×. The figure shows the relative proportions of a standard 35mm film aperture and the images of a 7.2mm diameter light source (approximate crater dimensions of an 8mm "Suprex" positive carbon) from three zones of the mirror: center, extreme edge and an intermediate zone. The solid lines of Fig. 1A show images from areas on a vertical diameter of the mirror while the dashed lines show the corresponding images from a horizontal diameter. The circular image produced by the central zone of the mirror has a diameter of 47mm corresponding to 6.6× magnification. The elliptically shaped images formed by the edge zone of the mirror have major and minor axis dimensions of 31.0- and 9.5mm, which are 4.3 times and 1.3 times larger than the diameter of the light source itself. The image areas thus vary from five times greater than the aperture area down to about one-half of the aperture area.

The distortion of the circularly shaped light source into elliptically shaped images is due to the foreshortened views of the crater seen from all off-axis zones of the mirror. To overcome the effect of this foreshortening, an aspheric lens was designed to spread each crater image in the direction of its narrow dimension.

Figure 1B shows the direction of the desired image expansion relative to the film-aperture dimensions for the crater image formed by the top or bottom edge of the mirror. A 100% correction of the image ellipticity converts the unexpanded image into a circle as illustrated. A 25% correction expands the image only one-quarter as much. The image, after a 100% correction, is larger in all dimensions than the film aperture, while a 25% correction produces an image with a minor axis just equal to the smaller dimension of the film aperture, as shown in Fig. 1B. The elliptical images from all zones of the mirror will be oriented in all possible directions on the film aperture and the expansion will always be in the direction of the minor axis of each elliptical image.

To spread the crater image formed by a small area of the mirror, a negative cylindrical lens element is placed in the cone of light from that area with the axis of the cylinder parallel to the long axis of the crater image. For all crater images originating in one annular ring of the mirror, the desired spreading action will be the same. This will be approximated by using an annular ring of a negative spherical lens having the same focal length as the single cylindrical lens. The physical size of the cone of light from a mirror element on such a lens will spread some parts of the image more

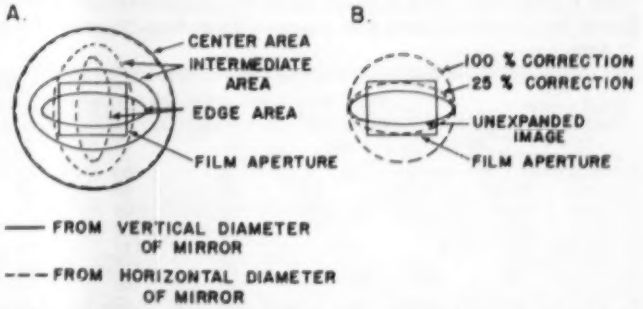


**Fig. 1. Crater images from elliptical mirrors (7.2 mm crater diameter, 6.6× axial magnification) (145° collection angle). A. Images from center, edge, and median areas of mirror; B. Expansion of top or bottom edge image.**

Presented on April 22, 1955, at the Society's Convention at Chicago by R. E. Harrington, National Carbon Co., Box 6087, Cleveland, Ohio.
(This paper was received on April 22, 1955.)

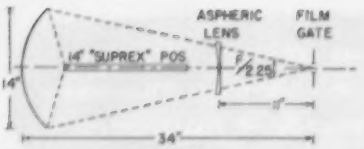


**Fig. 2. Normal mirror system with aspheric lens added.**

than others; however, the average spreading by the annular lens element can be made to give the desired spreading for the particular annular mirror zone. Since each mirror zone requires a different amount of spreading action, the focal length of the negative lens must vary continuously from the center to the edge.

The lens power needed in the aspheric lens for a particular mirror zone varies with the location of the aspheric lens, and is a minimum when the lens is halfway between the film aperture and the mirror surface. This distance is approximately 16 in. from the aperture with the usual mirror-type lamp using "Suprex" carbons. To allow for the length of the carbon, the aspheric lens was actually designed for a position 11 in. (280mm) from the aperture. Figure 2 shows the mirror optical system with the aspheric lens added.

Figure 3 shows the focal length required for 100% correction by the aspheric lens for radii corresponding to the mirror collection angles shown. The method used to calculate the focal length required for a particular mirror collection angle is given in the Appendix to this paper. With the focal lengths given in Fig. 3, each elliptical image is expanded into a circle having a diameter equal to the major axis of that ellipse. The curve, as plotted, is independent of mirror magnification since the amount of spreading needed is determined by the foreshortening from angular views of the crater. The curve applies only for the designed aspheric lens to aperture distance (280 mm). The focal lengths shown may be scaled up or down by an appropriate factor determined by the amount of correction desired. For example, if the images are to be expanded by 25% of the amount required to produce circular images for all mirror zones, the focal length in each zone would be four times that given in Fig. 3.

Expansion of the images will result in less light projected through the aperture. However, the light will be more evenly distributed. The unexpanded image from the edge of the mirror as shown in Fig. 1B, is smaller than the aperture so that there will pass some light which originates from outside the crater. Such light will not have the white color that is characteristic of crater light.

### Spreading Action for Improved Screen Distribution

To determine how much spreading action should be supplied, the amount of light passing a standard aperture was calculated for various amounts of spreading action using a modification of the method outlined by Jones.[1] The illumination on the film aperture from a particular mirror zone is the product of the source brightness and zone "lumen factor." The mirror was divided into 4° zones and the equations given by Jones used to evaluate the lumen factors for each zone. The locations in the source plane were calculated for points from which light must originate in order to reach the center, side and corner of the aperture. The effective brightness for each source point was obtained from brightness-distribution curves. The product of brightness and zone lumen factor gave the lumens/sq mm contributed by the particular mirror zone. The summation of the contributions from all mirror zones yielded the total lumens/sq mm at the aperture center, side and corner from which the total lumens passing through the film aperture were readily obtained.

Table I shows the calculated relative amount of light passed by the aperture, along with the side and corner distribution ratios for four amounts of image correction for two mirror types. The brightness distribution for a 70-amp "Suprex" carbon was used. The first mirror listed in Table I is still very common in theaters projecting with lamps using "Suprex" carbons while the faster mirrors of the newer, rotating-type lamps approximate the second type of mirror listed. The light passed by the aperture using the $f/2.25$ mirror alone (0% correction) is taken as 100%.

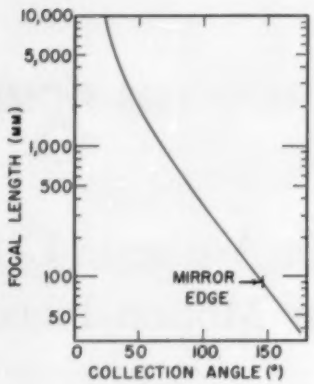


**Fig. 3. Collection angle vs. lens focal length required to make elliptical images circular (aspheric lens to aperture – 280 mm).**

The calculated relative lumen values of Table I do not include any reflection losses, so that the values show only the effect of image spreading. For example, comparing lines 1 and 5, 17% more light would be expected in changing from the $f/2.25$ to the $f/2.0$ mirror. If now the crater images from all mirror zones are made circular (100% correction — line 8), the relative screen light would be reduced to 97% (lower if reflection losses due to the aspheric lens are included) of the light level produced by the simple $f/2.25$ mirror system. However, the $f/2.0$ mirror with the aspheric lens would give a 77% side-to-center distribution compared to 61% for the simple $f/2.25$ mirror system.

Typical data for the variation in screen light with crater position show that the same screen light will be obtained if the desired side-to-center distribution is produced either by the spreading action of an appropriate aspheric lens (but neglecting its reflection losses) or by changing the crater position. However, the out-of-focus procedure results in a pronounced shift in screen color, as will be described later.

### Performance of Aspheric Lens With the Standard Mirror System

An aspheric lens giving a 25% correction of the crater images was obtained to test the actual performance of the system. This amount of correction was taken as a compromise between loss of light by the spreading action and improved color uniformity.

Table II shows the observed screen-light and light-distribution values obtained. The addition of the aspheric

**Table I. Calculated Effect of Image Correction on Quantity and Distribution of Light Passed by a Standard 35mm Film Aperture From 8mm "Suprex" Positive Carbon at 70 Amp.**

| | Axial mirror magnification | Mirror speed | Collection angle | Correction,* % | Relative lumens,† % | Light distribution ratios Side-to-center, % | Corner-to center, % |
|---|---|---|---|---|---|---|---|
| 1 | 6.6× | $f/2.25$ | 145° | 0 | 100 | 61 | 49 |
| 2 | | | | 25 | 94 | 67 | 57 |
| 3 | | | | 50 | 88 | 74 | 64 |
| 4 | | | | 100 | 72 | 87 | 80 |
| 5 | 5.0× | $f/2.0$ | 125° | 0 | 117 | 55 | 42 |
| 6 | | | | 25 | 111 | 61 | 47 |
| 7 | | | | 50 | 103 | 66 | 53 |
| 8 | | | | 100 | 97 | 77 | 66 |

* 100% correction converts an elliptical crater image into a circle; 50% correction spreads image only half as much.
† Reflection losses from added optical components are not included.

lens reduces the screen light by 24%, but raises the side-to-center distribution ratio from 60 to 67%. After correcting for the reflection losses from the surfaces of the lens, a 17% light loss (line 3) still remains. This is to be compared with a loss of approximately 6% which would be expected from Table I for 25% correction by the aspheric lens. On the other hand, the observed distribution ratios are close to the values expected from the calculations of Table I. The greater-than-expected loss in light is probably due to the limited accuracy of the calculations.

In mirror lamps, which already use a heat filter, added reflection losses from the aspheric lens could be avoided if the heat filter and aspheric lens could be combined into a single element.

**Table II. Effect of Aspheric Lens on Screen Light.**

| | Optical system | Maximum screen light* (lumens) | Distribution ratio Side-center, % | Corner-center, % |
|---|---|---|---|---|
| 1 | Mirror only | 14,200 (100%) | 60 | 48 |
| 2 | Mirror + aspheric lens | 10,800 (76%) | 67 | 55 |
| 3 | Mirror + aspheric lens (if no reflection losses)** | 11,800 (83%) | 67 | 55 |

* No projection shutter, $f/2.25$ mirror, coated $f/2.0$ projection lens, uncoated aspheric lens 70-amp — 40-v "Suprex" carbon arc.
** Assumes an 8% reflection loss by aspheric-lens surfaces.

### Screen Color Tests Using the Aspheric System

Screen color measurements were made for the same optical systems tested for total screen light. Two color variations were measured — the variation across the screen and the changes produced by crater movement. The color of the light incident to the screen was measured in terms of the spectral-energy distribution in the visible wavelength range obtained using a General Electric Spectroradiometer. The results do not include the spectral reflectance of the projection screen. The CIE trichromatic coefficients, corresponding to the spectral-energy distributions, were calculated by the selected ordinate method described by Bowditch and Null.[3]

Table III gives the comparison of side and center of screen colors for the two systems. The trichromatic coefficients specify the color in terms of the proportions of the CIE red, green and blue primary colors. For each set of coefficients, there is listed the temperature of the blackbody whose color most nearly matches the screen color as well as the color difference (in units of least perceptible difference — LPD's) between the screen color and the equivalent blackbody color. These quantities were calculated by the method described by Judd.[4,5] Color differences are given in LPD units, since these take into consideration the fact that equal distances at different locations in a plot of the CIE trichromatic coefficients do not represent color differences equally perceptible to the eye.

The last column of Table III shows the color difference between the center and side of the screen in units of least perceptible difference. The data show that at maximum light the color difference between the center and side of the screen is not large (only 3 LPD's) when using the popular $f/2.25$ speed mirror. The addition of the aspheric lens cuts this color difference approximately in half and also lowers the color temperature at the center of the screen slightly.

Table IV shows the color variation at the center of the screen as the crater is moved towards (T) or away (A) from the mirror from the position producing maximum screen light. Inspection of the column listing the equivalent blackbody temperatures shows that the screen color changes rapidly with changes in crater position. The last column shows the amount of color change per millimeter of crater motion for the two systems. The addition of the aspheric lens reduces the rate of color change to one third and so gives greater tolerance in crater positioning.

The changes in screen color with crater position, shown in Table IV, should be typical of good mirrors. Any appreciable deviations of the mirror surface from a perfect ellipse shape will add an excess of brown carbon-shell light or blue arc-stream light and thereby change the screen color at maximum light and modify the color variations with crater position.

The rapid change in screen color with crater position points out the necessity for close control of crater position if the proper color balance in the projected motion pictures is to be maintained. For the simple mirror system, a 1.9 mm shift of the crater from the maximum-light position decreased the equivalent blackbody color temperature from 6200 to 4850 K or about 700 K/mm of crater movement.

In the screen-light calculations it was pointed out that the distribution obtained using the aspheric lens could also be produced by the simple mirror system by moving the crater; however, this would not give the same screen color. The aspheric lens is preferred since its addition to the mirror system changes the screen color less, and yields an optical system which makes the screen color less sensitive to crater positioning.

The changes in screen color with crater position point out a basic difficulty involved in producing identical screen colors before and after changeover from one projector to another in a theater. A change in color will occur unless the two projectors have equivalent optical performance and have arc craters identically positioned. The same requirements must be met in any side-by-side comparisons. The difficulty of matching screen color from two projectors can be reduced considerably by the use of the aspheric lens, since the lens reduces the rate of color change with crater position. If the amount of screen light is not of major importance, an aspheric lens of still greater correction will give less screen light, but the color will be even less sensitive to crater position.

In general, as the optical speed of a lamp mirror is increased, both the color and brightness distribution over the screen become less uniform due to the decrease in magnification which accompanies the faster speed. However, the aspheric lens can then be combined with a too-fast mirror to give the same screen light as with a slower mirror alone, but with an improved color-and-brightness distribution.

### APPENDIX: Calculation of Required Lens Power

The equation giving the required focal length of each aspheric lens zone can be derived from the geometry of the system. Figure 4 illustrates a cross-sectional view

**Table III. Observed Effect of Aspheric Lens on Color Variation Across Screen; 70-amp — 40-v "Suprex" Carbon Arc (at Maximum Screen Light).**

| Optical system | Location on screen | Trichromatic coefficients* x | y | z | Color temp., equivalent blackbody K | Color departure from blackbody LPD's | Color change side-to-center LPD's |
|---|---|---|---|---|---|---|---|
| 1 Mirror alone ($f/2.25$) | Center | 0.3180 | 0.3513 | 0.3307 | 6200 | 29 | 3.0 |
| | Side | 0.3181 | 0.3490 | 0.3329 | 6190 | 26 | |
| 2 Mirror + aspheric ($f/2.25$) | Center | 0.3234 | 0.3558 | 0.3208 | 5930 | 28 | 1.6 |
| | Side | 0.3223 | 0.3548 | 0.3229 | 6000 | 28 | |

* These values apply to light illuminating the screen and do not include the effect of spectral reflectance of the screen.

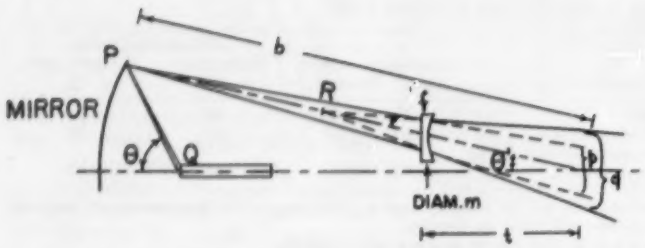


***Fig. 4.* Expansion of crater images by aspheric lens.**

of the optical system and how the spreading action is brought about. The source Q is imaged by small area P of the elliptical mirror onto the aperture. The image is foreshortened by the ratio $\frac{\cos\theta}{\cos\theta'}$, in the plane of the drawing, but will undergo no foreshortening perpendicular to the paper. The foreshortened image width p must be expanded by the negative cylindrical lens element to a diameter q to produce a circular image. The negative lens diverges the cone of light so that it appears to diverge from R instead of P. If f is the focal length of the added lens and $t'$ the distance from the lens to the aperture, the simple lens equation will be:

$$\frac{1}{f} = \frac{1}{b - t'} - \frac{1}{r} \qquad (1)$$

By geometry the following relations must hold:

$$\frac{m}{r} = \frac{q}{r + t'},$$

$$\frac{m}{b - t'} = \frac{p}{b}$$

$$\text{or } \frac{q}{p} = \frac{r + t'}{r} \cdot \frac{b - t'}{b} \qquad (2)$$

Combining equations (1) and (2)

$$\frac{q}{p} = 1 - \frac{t'}{f} + \frac{t'^2}{bf} \qquad (3)$$

If the source is one unit in diameter, the foreshortened image will be $\frac{\cos\theta}{\cos\theta'}$ wide so that to make the image circular the needed expansion $\frac{q}{p}$ will be:

$$\frac{q}{p} = \frac{\cos\theta'}{\cos\theta} \qquad (4)$$

Combining equations (3) and (4) and rearranging, the final equation is:

$$-f = \frac{\cos\theta}{\cos\theta' - \cos\theta} \cdot t' \cdot \left(1 - \frac{t'}{b}\right)$$

This equation gives the focal length of the zone in terms of the constants of the system. For each mirror zone, the angles, as well as $t'$ and b, can be calculated and the required focal length determined.

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## Discussion

*John R. Miles (John R. Miles Company)*: I can understand how this aspheric lens would improve the distribution of the lights as well as the color, but I believe that it may be due to the correction of the coma in the elliptical mirror, since the edge of the mirror produces a magnification different from that at the center. I wondered if you would agree with me on this.

*Dr. Harrington:* The aspheric lens does not eliminate aberrations. It spreads out the crater image from each small area of the mirror to overcome the effects of foreshortening, but does not affect the change in magnification between the center and edge of the mirror.

*Mr. Miles:* In the first slide it looked as though there was a lack of symmetry about the axis of the system. Does this mean that the crater is elliptical in a horizontal direction, and not symmetrical?

*Dr. Harrington:* No, the complete image is symmetrical. Just the images from one particular diameter of the mirror were shown in the first slide. As one traverses outward from the center toward the edge of the mirror in any particular direction, the appearance of the crater, as seen from the mirror, becomes more elliptical in shape. However, the illumination of the aperture by the entire mirror produces a circular spot of light.

*Dr. Charles R. Daily (Paramount Pictures)*: How does the performance of this aspheric system compare with the Zeiss honeycomb condenser auxiliary system that is used in their projectors to accomplish a somewhat similar result?

*Dr. Harrington:* I believe that with the aspheric system, one should obtain considerably more light. The Zeiss condenser system uses two additions to the optical system and so causes extra reflection losses. However, it will give a more uniform screen light distribution unless a new aspheric lens is made which would spread the images more than does the present lens correction of the images.

*Dr. Daily:* Does the Zeiss system have a greater light loss than this system?

*Dr. Harrington:* I believe so. In the Zeiss system, an element in the first honeycomb lens produces an image of the crater on the corresponding element of the second lens. When this image is too large, light is lost. The Zeiss system is particularly useful for small light sources, but becomes less efficient with carbons larger than 7 mm in diameter due to the increasing light loss in the second lens.

*Dr. Daily:* Does the honeycomb achieve a greater freedom of position of the carbon, similar to your system?

*Dr. Harrington:* Surely.

*Dr. Daily:* With regard to the elliptical shape of the crater image, studies that we have made of the higher current type of carbons indicate that as the crater depth increases there is a considerable part of the inner portion of the arc crater that is not seen by the light-collecting system, which seems to indicate the need of a very flat burning carbon so that the highest brightness portion can be seen by all parts of the condensing lens. Has any work been done to minimize this shadowing of the light source by the carbon itself?

*Dr. Harrington:* First, we published a paper several years ago [Ref. 2 above] in which we showed that the apparent source of light for the normal crater depth is only about one millimeter from the crater face so that, apparently, the effect of depth is actually not serious in present carbons. Second, in the carbon arc, the source of light in the crater depends on a rather complex balance of the energy in the crater region. If you try to make a shallow carbon, you have no way of knowing that you will be able to maintain the energy conditions necessary for high brightness at reasonable current and consumption rates.

*Dr. Daily:* That may well be. We now have some experimental carbons with thinner shells that will be tried out for reduced shadowing and stability of burning characteristics. In our first study of the effect on light output of crater depth, photographs were taken of the crater, from all angles that could be seen by the light collecting system. The image on the color film was the same size as the source, and the exposure was adjusted so that the brightest part of the source was still on the straight-line portion of the film characteristic. These pictures revealed that the brightest part of the crater was below the rim of the outer shell, so that at high angles with respect to the axis of the carbon there was a decisive shadowing effect that reduced the total amount of light reaching the outer portion of the collecting system.

**Table IV. Effect of Aspheric Lens on Screen Color Variations with Crater Movement (Color at Center of Screen).**

| Optical system | Crater* position (mm movement) | Trichromatic,† coefficients x | y | z | Color temp. equivalent blackbody K | Color difference of screen color and blackbody color LPD's | Color change per mm crater movement LPD/mm |
|---|---|---|---|---|---|---|---|
| 1 Mirror alone | 1.9T | 0.352 | 0.379 | 0.268 | 4850 | 27 | |
| *f*/2.25 | Max | 0.318 | 0.351 | 0.331 | 6200 | 29 | 21 |
| | 2.9A | 0.298 | 0.315 | 0.387 | 7550 | 8 | |
| 2 Mirror + aspheric | 3T | 0.338 | 0.363 | 0.299 | 5300 | 21 | |
| *f*/2.25 | Max | 0.323 | 0.356 | 0.321 | 5930 | 28 | 6.6 |
| | 3A | 0.311 | 0.343 | 0.346 | 6550 | 28 | |

* This column gives crater position relative to maximum-light position. Movement of indicated number of millimeters towards mirror (T) or away from mirror (A) is measured from maximum-light location.

† These values apply to light illuminating the screen and do not include the effect of spectral reflectance of the screen.

# Film Problems in Television News Reporting

By SPENCER M. ALLEN

**This is a semitechnical review of the problems confronting a television news editor who has had little or no experience with motion-picture film, and how he has learned to use the motion-picture art to develop a new type of journalism. The principal differences between old-style theater newsreel reporting and modern-day television news reporting are outlined. Some of the devices used in attempting to overcome the shortcomings of orthodox pan films, single-system soundtracks, developing and light problems, etc., are pointed up. Needs and improvements in film techniques and associated equipment to keep up with the fast pace of the television art are recommended.**

Many of the points I make will be very basic and elementary to you, but my B.A. degree did little to prepare me for such terms as resolution, gamma, variable density, ASA and Weston ratings. I had to find out about these things the hard way. And I continue to learn something new every day about this visual art which television has forced into a shotgun wedding with the news profession. Although my remarks are in the first person, I believe that you'll find my experiences rather typical of some very confident radio news editors who found they had to learn their business all over again.

To background the evolution of television news — and that evolution is still taking place — let's go back about eight or nine years when postwar television sprang in full bloom on the American scene. As you know, most television stations were licensed to existing radio stations. It was only natural that people experienced in the way of radio were to inherit television. After all, we said, television is just radio with pictures. It didn't take us long to find out that television was much more than visual radio.

To get down to the news profession, we in radio were riding rather high in 1946 and '47. We felt that we had attained a pretty high perfection of the art. During the war years, we had developed the technique of shortwave pickups from almost any point on the globe. Wire-line remotes to every nook and cranny in the country or in a city were common occurrences. With the advent of the wire recorder — and later the tape — we were able to develop our own type of radio newsreel. Our microphone and recorder could be taken almost any place, narration or interview made on the spot — later edited and played back on the broadcast frequencies. And as I look back, it was pretty good on the whole — and it still is, if you listen to the radio now and then. Moreover, it was a rather relaxed state of endeavor we had reached. That is one of my greatest regrets. We don't relax much any more.

We blithely assumed we would use our radio techniques to present news on television. Immediately, we came croppers. Number one: you don't do TV remotes from all points of the globe by short wave — it isn't technically feasible, even today. Number two: line remotes from around the country. They can be done — they are now being done by some network news shows with rich sponsors. What about the TV counterpart to a tape recorder, the sound movie camera? This recorder of the visual and the aural is today our basic unit in covering the news for television.

Theoretically, the parallel to a tape recorder holds; in practical application, the differences are many. For example, let's take the average press conference, where reporters meet with a man who can give us news by question and answer. This field used to be the private preserve of the newspaper reporters, who made notes. We radio reporters then began sticking our tape microphones in the middle of such interviews and hitchhiked, so to speak, on these press conferences. Later, we gained more confidence in ourselves as working reporters and began to participate actively in the conferences along with the newspaper men. They weren't at all sure we belonged there, but gradually they came to accept us — or at least to tolerate us. With a tape recorder, our technique was to let the recorder run continuously — we could record up to an hour at one time. We would have the whole business on our tape. Tape is relatively cheap, it can be edited simply, no development process is required, and the tape can be erased and used over and over again.

Then some of us graduated to television reporters. Instead of bringing in some simple gear, with one operator to run the machine, we appeared on the scene with a dolly piled high with a sound camera and associated equipment such as lights and cables, and a three- or four-man crew to operate the business. The newspaper reporters put us back in the doghouse, because now we were really fouling up their quiet little press conferences — and I must confess they had reason to complain. The lights were bright — and hot. Cables were strung all over the place. Our early newsreel cameramen were from the old theater newsreel school, not noted for their gentle demeanor or tact. Many of them continued to demonstrate their competence and experience by banging their tripods and slamming equipment around, as well as showing a haughty disregard for the subject of the press conference. I'm happy to say that either those cameramen didn't last, or they mended their ways to blend in with the usually peaceful atmosphere of the press conference.

At first, we attempted to operate our sound cameras as we did the tape recorders — let them run continuously during a press conference. Several things happened. One, our budget went skyhigh. Thirty minutes of film is more than a thousand feet, and its cost is about $35. Two, we jammed up our processing facilities. Three, our film editors were swamped with film they couldn't adequately handle for deadlines an hour or less away. At an average press conference, we are looking for either the high spot of that conference, or an answer from the subject that may summarize the whole tone in two to three minutes — 70 to 100 ft roughly. So, as is readily apparent, continuous running is extravagant both in money and time. We soon had to devise another method or go broke. The continuous method is still used, however, for the Presidential press conference which is filmed in its entirety nearly every Wednesday at the White House. I want to come back to that subject later.

### Present Techniques

The technique we employ now where possible is to set up a conference separate from the one for the newspaper reporters. Our conferences are boiled down to two or three leading questions to the subject, quite often pooled with other television newsreels. We're happier with this arrangement, so is the subject, and so are the newspaper boys. The disadvantage is that there is a tendency for such conferences to become stereotyped. And seldom do we get those spontaneous

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or unexpected reactions from subjects that we used to catch when we were filming everything and might catch the subject in an unguarded moment.

That brings us into another aspect of television news reporting that has long been one of our major problems — that of lighting. No subject can act naturally — nor can he ever forget the camera is on him — when around 2000 w of light is burning into him from 8 to 10 ft away. The subject is conscious of the camera, he is acutely aware of the lights. Moreover, the lights make him physically uncomfortable — and it is quite often apparent in the finished film. We seldom can get the casual or easy responses to our questions on film made indoors that we used to get on tape.

### Types of Film

Until fairly recently, the fastest film we could secure was Eastman Double-X or Du Pont 931. Under our processing standards, we have assumed an ASA speed rating of 125 for these films. That used to be considered pretty fast film. In fact, some of the old pros were quite horrified to find we were using such films. They were accustomed to using the slower films, with hotter lights, which they justified by getting better quality. For studio productions, they're probably right. For news work, it's almost impossible for us to use slower film while working on fast-moving stories, especially with hand-held cameras in silent coverage, when a cameraman, with a portable battery light clamped to his camera, may have to move down a hallway to keep a subject in his field and in focus. But even ASA 125 wasn't fast enough, because auxiliary lights were still needed in an average lighted interior. That situation was helped somewhat last year when Eastman came out with Tri-X, and most newsreel services have gone over to it for their inside work.

The example of news coverage I've used so far has been the press conference. There are dozens of others, of course. They may range from so-called man-on-the-street interviews, where lighting is not so much of a problem, to filming a little boy crying in a basement while firemen try to free his foot from a floor drain. This television reporting by film should be a personal and intimate sort of thing, picturing a situation much as a spectator might see it were he on the scene. That intimacy can be melted away by unnecessary lighting.

There is another type of reporting that the advent of television has done much to develop. That is bringing into the homes of Americans the operations of government. It got its big break during the Kefauver hearings, which were televised live as well as by newsreel cameras. Although we broke the ice in this and similar ventures, we also damaged our claim of right of access to news with other media, because of our lights, as well as bulky, conspicuous equipment.

Had it been only live TV, we could have gotten by with much less light, as the image orthicon of the TV camera can see better than the human eye. But our film cameras required the lights — hot and bright. After the novelty wore off, we weren't so welcome any more. Now, with Tri-X we have a talking point in that we can in most instances use the normal lighting of an interior. It is regrettable that we had to wear out our initial welcome so soon, and now have to fight our way back into the halls of government. But we are slowly getting back. Our cause was greatly advanced when President Eisenhower consented to filming the weekly press conference at the White House for distribution by television. We have to thank the advent of Tri-X for that achievement, because we otherwise would not have been permitted to make the films. If you've seen any of these films, you'll note that the President seems comfortable and at ease. He doesn't squint, he reacts naturally, and he doesn't visibly perspire — and he certainly would have done so with the lighting required for newsfilm a year ago.

I hope we television johnny-come-latelys don't appear to be impatient or ungrateful, but we waited a long time, in terms of our short span of years, for a really fast film to be produced. We knew from our first day of operation that Double-X and 931 would not be fast enough for our work. Now, we're waiting for a comparable fast film to be developed in reversal black-and-white, as well as in color.

There are some other aspects of the photographic development and manufacturing field which, to us, appear to be moving slowly. For instance, let's consider sound cameras:

### Camera Needs

It became quite apparent when we began television news that we would be using primarily the 16mm camera for reasons of economy as well as portability. Again, we wanted something akin to the radio tape recorder. Because of the time element involved in editing and telecasting film, we had to use single-system sound. Double-system was not only expensive but also time consuming. Yet for several years only one major camera manufacturer has been able to supply us with this type of equipment. And it was designed originally for those amateurs who did not need to consider cost — not for television news work.

There is also need for a magnetic recording head in a camera. I note that one of the other papers to be delivered to this convention deals with just such a device. But it is a modified camera such as I spoke of a moment ago — and the modification was done in Germany, not in the factory that made the camera in the first place. We have long had the problem of compromise processing of single-system sound film in order to achieve picture and optical track in the same development. With a magnetic track, we not only could concentrate on optimum development for picture, but also should be able to obtain a higher quality soundtrack than we can with the average single-system optical. This means, of course, the striping of film as an integral part of its manufacture — not post-striping, which now costs about as much as the original film.

I'm sure many of you may be thinking that there are already methods whereby a separate tape can be synced to the picture film, either electronically or mechanically, so why bother with the development of a totally new method of sound-film recording. The answer for us in the news business is twofold: time and money. In a tight pinch, a film cutter can edit a single-system sound-film story in, say, 15 or 20 min. His sound is with the picture — all on one piece of film. And when we are dealing with a highly perishable commodity — news — time is of the essence. If we are faced with the problem of syncing a separate piece of tape with the corresponding film, more time is expended and another man is required. So, up goes our time in preparation, and up goes our payroll. The present system of synchronized tape and film is fine for studio work, where there is adequate time to prepare them properly and to re-record if necessary. In the television news business we don't have that time, for our time is measured in minutes, not in days or weeks.

In this discussion so far, I have assumed we're speaking of an individual television station in business for itself only, and not faced with the additional problem of syndication, as are some of the networks, or syndicated services. In our case at WGN-TV, we are concerned with the production of films that are to be shown probably three times at the most — usually only once. We rarely need to produce extra prints. When we do, we can get a passable positive reversal print. The magnetic sound proposal I have made might not solve the problem of speed for those services which must syndicate, as there would then be the problem of reproducing the magnetic track on prints. This would call for modification of existing printers, which might not be too much of a job. But for those stations that must syndicate as well as project their original film in negative — reversing polarity electronically — there would still be a great advantage in sound quality. I have yet to hear a track that can reproduce equally well in negative or positive. The soundman must compromise between the two extremes when he remembers his track may be reproduced in both the negative original form and the positive print.

The need for better sound reproduc-

tion is being emphasized because seldom do we have conditions under which we can record as in a studio. Most of the time the microphones are hand-held, perhaps in an echo-filled hall or outside where wind and traffic compete with speech intelligibility. Quite often, where it is not feasible to set up our own microphones, we must bridge in on public-address systems. These are some of the natural handicaps in our business which make the improvement of sound recording on film imperative.

Referring again to reversal film, some may feel we could get better resolution out of an iconoscope tube using negative. The improvement may show up on the slide rule or on the oscillograph, but I'm not so sure that it is apparent to the average eye. Many bad things can happen to a film picture from the time it is scanned on the TV projector until it is reproduced on the home television set — which has it's own brightness and contrast controls. How much of the improvement would show up on the average home set is problematical. In the opinion of the people who have to work with this film in our newsroom, being able to edit film in positive is, again, a great timesaver. For the news writer, who must identify six people in a 16mm frame, it's hard enough to do it in positive. It would be almost impossible in negative. And when we must go into our morgue and pull out film to supplement a current story, a quick glance at the positive image in the viewer confirms that this is the film we're looking for.

### Effective Technical Compromises

I cannot think of any better example than television news work of the need for compromise between the technical people who wish to develop the art to its highest state, and the people who must put those developments to practical application. If engineers were to have their way, we would have beautiful pictures and high-fidelity sound, but by the time we got the film on the air it wouldn't be news — it would be history. We news people are more concerned with how much we can get on film, and how soon we can get it on the air — and I must confess that I've seen and heard some pretty sorry looking and sounding newsfilm on the air. But if it is a scoop, we feel pretty good about it.

There is at least one other item of equipment in which there has been no progress in years. That is the simple little hand splicer. In order to join two pieces of film, our film editor must go through at least ten individual steps. And he still must scrape the emulsion with an emery stick or razor blade. One film manufacturer has now made it necessary to scrape both the emulsion and the shiny side — adding half a dozen more steps to the splicing process. And when we do get a splice, it is more than two film thicknesses deep, so that it sometimes snags in the projector gate and helps to create scratches in the film. Surely the brains and talent of the designers of intricate camera mechanisms could devise a simple type of splicer that would trim, scrape, if necessary, and butt-splice film, chemically, electronically or mechanically — all in one operation. I spliced my home movie film twenty years ago in exactly the same fashion my film editor does it now — only I didn't have to scrape both sides of the film then.

Now for the future of television news — what do we look forward to? The first thing that comes to mind is, of course, color. Like it or not, we shall eventually be obliged to shoot news film in color, although it may be the last thing to depart from monochrome. Many of us dread the change because we see the already complicated problems of handling black-and-white film multiplied twenty-fold — in price, time and trouble. Shall we have to wait several years before we get color film to match black-and-white in speed, price and ease of processing? Frankly, we may not wait for the film manufacturers to satisfy that need. We're impressed with what has been done with magnetic tape in recording and reproducing pictures — black-and-white and color. True, the present equipment is bulky, it's expensive, but it has promise. And it may be that the electronics laboratories will produce in the not too distant future small cameras no larger than a present 16mm sound camera — or possibly even a hand-held silent job — that will record on tape instead of film. There would be no processing laboratory to maintain, meaning decreased personnel and overhead. And the tape could be used over and over again, another cost factor thus being licked.

In conclusion, I reiterate that I am a layman in relation to the field in which most of you are engaged. Television news editors, such as myself, use your developments as the tools of our trade. We may often use these tools in fashions and for purposes that you did not contemplate. And because we have adapted them for wider uses than they were intended, we are perhaps too often critical of the shortcomings of these tools. Yet without them, we could not operate. The old adage about mousetraps still applies to cameras and film and general photographic devices. Keep us in mind as you plan and devise and improve. We're waiting to beat that path to your laboratory door.

### Discussion

*George Lewin (Pictorial Center Signal Corps.)*: In regard to the questions raised about the lack of proper equipment, the right people don't seem to get together, because right here at this convention, yesterday, we saw a 16mm camera with a magnetic head installed which gave acceptable quality.

*Mr. Allen:* Is that on the production line?

*Mr. Lewin:* No.

*Mr. Allen:* We have seen experimental models for years, but I would like to see them in an equipment catalog somewhere at a reasonable price.

*Mr. Lewin:* Isn't it up to the people who need the equipment to help accomplish that? Now you also mentioned the splicer. We know that a butt-weld splicer has been around for several years. The price may be high, but it certainly can make a splice in a matter of a few seconds.

*Mr. Allen:* Again, is that in production?

*Mr. Lewin:* As far as I know.

*Mr. Allen:* We see them at conventions, but never on the market.

*Mr. Lewin:* Again, along the lines of splicing, we know that DuPont has come up with a transparent film and that will shortly be available. I understand there are various manufacturers interested in making a splicer—using this film—which will be able to make a splice in practically a matter of seconds.

*Mr. Allen:* I've seen that but as of today I can't buy it.

*Ralph E. Lovell (NBC Hollywood)*: Would you be willing to spend the money to buy cameras and projectors and additional editing devices to actually put this magnetic stripe on the air? And, secondly, would you be willing to learn the new techniques in editing, for example, that would be necessary to get magnetic stripe actually into your production?

*Mr. Allen:* I think we certainly would because as far as I can tell, at least from the editing end, I don't think that our problem would be greatly exaggerated or different from what we have now on an optical track. I assume there would still be 26-frame lag.

*Mr. Lovell:* Not necessarily. There are certain people who are advocating that we arrange it so that sound would be recorded right beside the pictures.

*Mr. Allen:* That would be even better. In fact that would simplify rather than complicate our editing procedure. There is one question though that comes up in relation to that, something some of our own engineers have told us. How serious it is I don't know. Is there a great difficulty because the strobe light from the TV projection camera sets up too much of an interference field for the magnetic recording head?

*Mr. Lovell:* That has been a problem definitely. There are some plans to get around that (controversial at the moment) but I think that the day is coming when satisfactory reproducing methods can be arranged.

# Control of Light Intensity in Television Projectors

By K. SADASHIGE and B. F. MELCHIONNI

**RCA's television projectors used with vidicon film cameras are equipped with a light-intensity control unit developed for this purpose. The unit is used to control the video output level of the camera by varying the intensity of the projector light source to compensate for varying film density. The angular position of a continuously variable neutral-density filter wedge placed in the condenser-lens system of a projector is remotely controlled by a servomechanism. Thus the signal-to-noise ratio of the system is maintained at its optimum value since the camera is operating with essentially constant input level.**

THE ADVENT of the vidicon into the television film-pickup field has introduced a new requirement. This is the matter of maintaining a constant signal level in the system regardless of wide variations in film density. The iconoscope handled such variations with relative ease because of its inherent action as a limiter. Results of relying completely on the self-limiting action of the iconoscope were not ideal, but were satisfactory enough to be accepted in lieu of more complicated systems of control.

The vidicon, though it has a "gamma" of less than unity (in its present form), responds to light variations over a wide range. This is a desirable characteristic in one sense because it permits much more accurate reproduction of tonal gradation in picture whites than was formerly possible, but on the other hand a method is required for restricting the range of light to values suitable for the system. Presently available film is so variable in average density (broadcasters often have to deal with variations of up to 100 to 1 in film from different sources) that a method of controlling the intensity of the light source is desirable. It should be added that adjusting video-amplifier gain over such ranges is limited because of resulting variations in signal-to-noise ratio.

Video-amplifier gain controls have been generally accepted when used with the single monochrome type of equipment. This system is not applicable in our three-vidicon color system where the gain of three amplifiers must track as they are varied.

Several methods of controlling the intensity of the projection light source have been developed for the purpose of maintaining a constant video-level output from the film camera.

Although they do not represent a true form of light-intensity control, irises have been extensively used for television cameras. The most serious disadvantage of this system is that the depth of focus of the field is a function of the opening. Therefore, when the iris is used in a television film projector the flatness of the projected field cannot be maintained over a wide range of iris opening, because unwanted surfaces such as condensing-lens optics and lamp filaments will come into focus when the iris is stopped down.

Control of the source voltage of the projection lamp has also been employed. The source voltage may be controlled locally by a variable auto transformer or remotely by a controlled saturable reactor. However, this approach to the light-intensity control problem is not practical if it is applied to color-film reproduction because the spectral-energy distribution of an incandescent lamp is a function of the temperature. By taking 550 mμ (green) as an arbitrary reference the relative intensity of the 700 mμ (red) wavelength is increased by 40% while the 400 mμ (blue) wavelength is reduced to only 70% of the standard value if the source voltage of a 120-v, 1000-w projection lamp is reduced to approximately 60 v. Under this condition, the overall visible light-output level of the lamp is 10% of the nominal value. This method of light control is acceptable in monochrome systems using the vidicon tube.

A much more attractive approach is to control the transmission of the optical system. A device has been developed to control the illumination of a projector aperture by varying the angular position of a continuously variable neutral-density filter wedge, thus compensating for the varying density of the film and maintaining a constant video-output level.

This type of light-intensity control has the following distinct advantages over the other systems described previously:

(1) The spectral-energy distribution of the projector light output is essentially constant because the filter wedge used in the device is neutral in the visible spectrum.

(2) A wide range of control is available. A light intensity range of 100 to 1, which is more than adequate to handle most color and black-and-white films, is obtained by using a filter wedge of approximately 6 in. in diameter.

A limitation of the system using a neutral-density filter wedge is that the filter is made of carbon particles suspended in a gelatinous medium. Being an organic compound, the gelatin is subject to deterioration by heat. This problem is further complicated by the fact that in

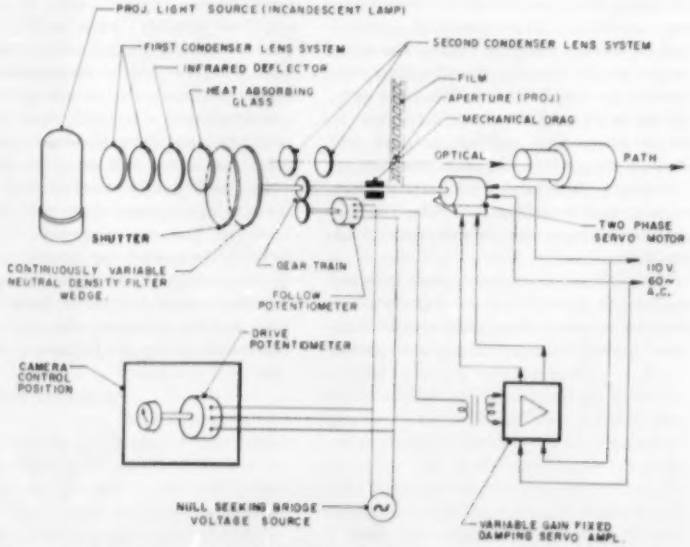


**Fig. 1. Functional diagram of light-intensity control.**

Presented on April 20, 1955, at the Society's Convention at Chicago by K. Sadashige and B. F. Melchionni (who read the paper), Engineering Products Div., Radio Corp. of America, Camden 2, N.J.
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order to remove the effects of shading caused by the density gradient of the filter wedge it is situated in the condenser-lens system of the projector.

### Description of This Control in a Typical Projector Design

Figure 1 is the functional diagram of the neutral-density filter-wedge type light-intensity control. The filter wedge is placed in the condenser-lens system of a film projector. As shown in Fig. 2, the filter wedge is made of a Wratten filter sandwiched between two pieces of optical glass plate to give sufficient rigidity for mounting. The density of the filter varies continuously from 0, or essentially 100% transmission, to 2, or 1% transmission with a gradient of 0.006 density unit per 1° of angular rotation. The center of the filter portion of the wedge is placed in the axis of the optical path. Horizontal shading due to the density gradient of the filter wedge is noticeable when it is placed anywhere other than in the condenser-lens system. By integrating the filter wedge into the condenser-lens system the observable shading has been eliminated.

In the condenser-lens system infrared rays, as well as visible light, are highly concentrated. The intensity of the infrared rays is sufficient to raise the temperature of a blackbody to 250 C within a few seconds after it is placed on the axis of the condenser-lens system of an RCA Type TP-6 16mm film projector. At this temperature the gelatin material of the filter wedge will be damaged within a matter of seconds. By placing two infrared filters between the light source and the filter wedge the temperature of the filter wedge is held below 60 C, which has proven to be a safe temperature for the neutral-density filter material.

A potentiometer is coupled to the drive shaft of the filter wedge by a gear train. Another potentiometer is located at the camera-control position. These two potentiometers form a bridge circuit as shown in the schematic diagram Fig. 3.

The difference in electrical potential between the arms of the two potentiometers is fed to an a-c servo amplifier. The output of the servo amplifier is fed to one of the two fields of a 2-phase servo motor, and in turn the servo motor drives the neutral-density filter wedge. The servo amplifier and two potentiometers form a null-seeking bridge circuit. If a potential difference between the output of two potentiometers exists, the output of the servo amplifier drives the following potentiometer which is coupled to the servo motor by a gear train until the potential difference between drive and following potentiometers becomes zero. Thus, the output signal of the servo amplifier also becomes zero, the servo motor develops no torque and the filter wedge stops at a specific point. The camera operator can, therefore, remotely control the angular position of the filter wedge by merely rotating the driving potentiometer at the camera-control position. There are no mechanical connections or linkages between the filter-wheel mechanism and the driving potentiometer. The camera-control position can be located anywhere in the studio and the interconnections can be made by a conventional two-conductor shielded microphone cable. As is often the case in servomechanisms we encountered a degree of mechanical oscillation of the filter wedge. It has been found that the electrical damping introduced into the servo amplifier is insufficient to eliminate the oscillation because of the fact that the moment of inertia of the filter wheel is fairly large. The oscillation of the disk was eliminated from the system by introducing a mechanical drag to the filter-wedge driveshaft.

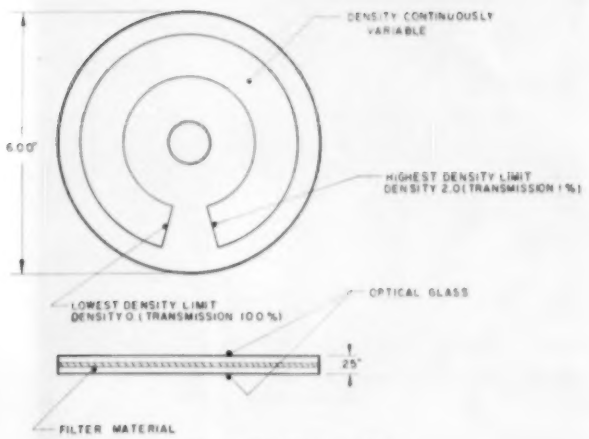


Fig. 2. The filter wedge.

### Problems Encountered in the Course of Development

The first problem encountered during the course of the developmental work was to determine what type of remote-control system to use.

A combination of a synchro transmitter and a receiver was first proposed. In this system, the mechanical drag of the filter-drive mechanism is reflected back to the control knob, whereas in the system finally selected this condition does not exist.

An amplidyne offers almost the same advantages as a servomechanism. It is fast in reaction, mechanically rigid, and careful maintenance is not required. However, a unit of suitable capacity was not available at the time and this system was not used.

A simple form of position servomechanism was finally chosen on the basis that it offers the following advantages which are considered to be important:

(1) The reaction time can be shortened

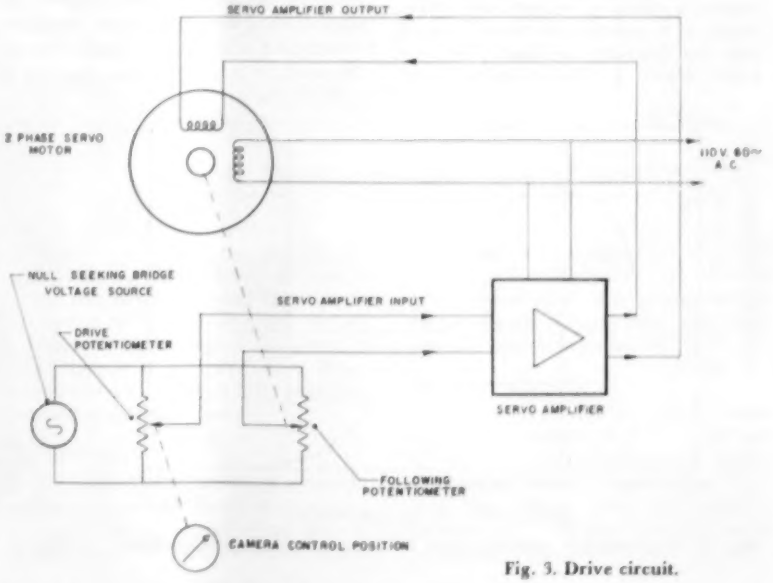


Fig. 3. Drive circuit.

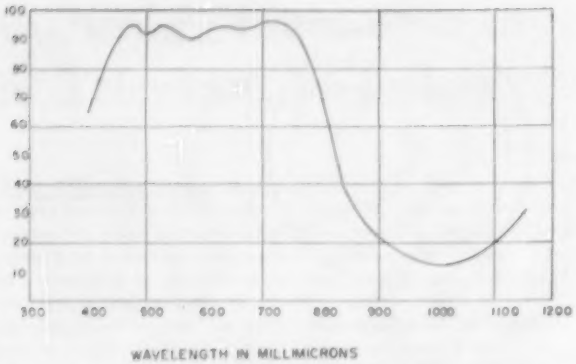


**Fig. 4. Spectral transmission curve of Fish-Schurman Type XUR infrared deflector.**

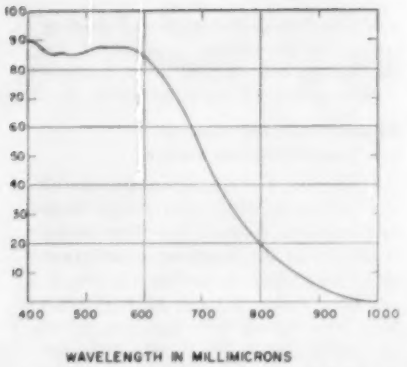


**Fig. 5. Transmission characteristics of Pittsburgh heat-absorbing glass Type 2043X 4 mm thick**

to a point where there is virtually no time lag between the rotation of the control knob and the motion of the filter wedge.

(2) By combining mechanical and an electrical damping an extremely smooth operation can be assured.

(3) The operator retains the "feel" of the control without the disturbing effect of mechanical drag.

The second but more serious problem was that of removing the infrared rays from the optical path before reaching the filter wedge without distorting the original spectral-energy distribution in the visible range of the projection lamp.

It has been found that if the filter is stationary for a period of time even a small amount of infrared ray left in the optical path causes damage to the neutral density filter material because infrared is accumulated in a small spot of the filter and raises its temperature to a point sufficiently high to damage it. A filter having a sharp cutoff point at about 700 mμ was required. A sharp dip at the wavelength of 1000 mμ is especially effective because this wavelength is a primary source of infrared from an incandescent lamp. Two infrared filters, a Fish-Schurman Type XUR infrared deflector and Pittsburgh Glass Works Type 2043X heat-absorbing glass (tempered) are placed in the optical path between the light source and the neutral-density filter wedge.

Proper selection of the infrared filters is of utmost importance because it may alter the color characteristics of the projection lamp around which the television color-film reproduction system has been designed. Characteristics of the filters used in the system are shown in Figs. 4 and 5 respectively.

As shown in Fig. 6, the combination of two filters transmits less than 1% at the wavelength of 1000 mμ which is, as previously stated, the prime source of the heat from an incandescent lamp, yet transmission characteristics at 700 mμ and 600 mμ are 50% and 74% respectively.

### Light Intensity Control for Slide and Other Projectors

The system as described thus far placed the neutral-density filter wedge in the projector at the optimum position for least shading error, namely in the cross-over region of a relay condenser system. However, it is quite obvious that this is not always possible when one is attempting to use existing equipment.

A neutral-density light-control unit has been designed which may be used with any projector where this type of control is required. This unit was intended primarily for use with slide projectors in the three-vidicon camera system. However, because of the nature of its design it can be used in the optical path of any projector providing there are no physical limitations.

This unit is a complete self-contained package (see Fig. 7) which includes the servo amplifier, drive motor, gear train and the neutral-density wedge. The unit need only be supplied with 110-v 60-cycle power and three conductors from a remote-control location.

It is obvious immediately that because of the density gradient of the wedge an observable shading component would be introduced into the picture. This difficulty was overcome by having a stationary wedge sector with the same density gradient as the minimum portion of the neutral-density wedge inserted in the optical path with the slope of density variation reversed with respect to the wedge.

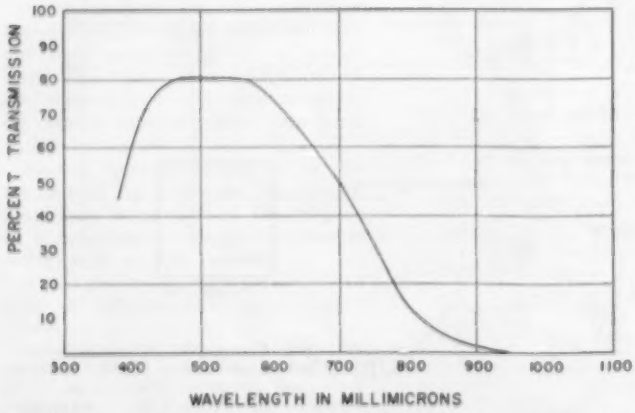


**Fig. 6. Transmission characteristics of infrared filter combination.**

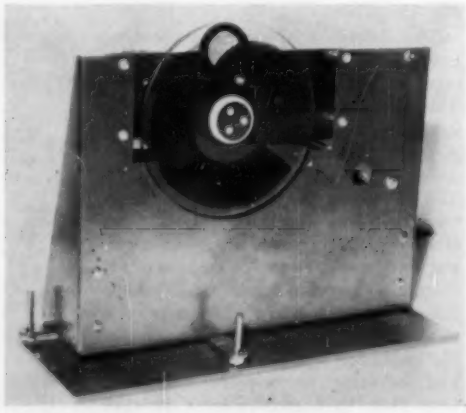

**Fig. 7. Light-intensity control unit for slide projector, with cover removed.**

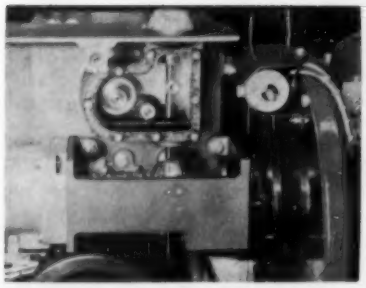

**Fig. 8. Light-intensity control mounted in an RCA TP-6CC Projector.**

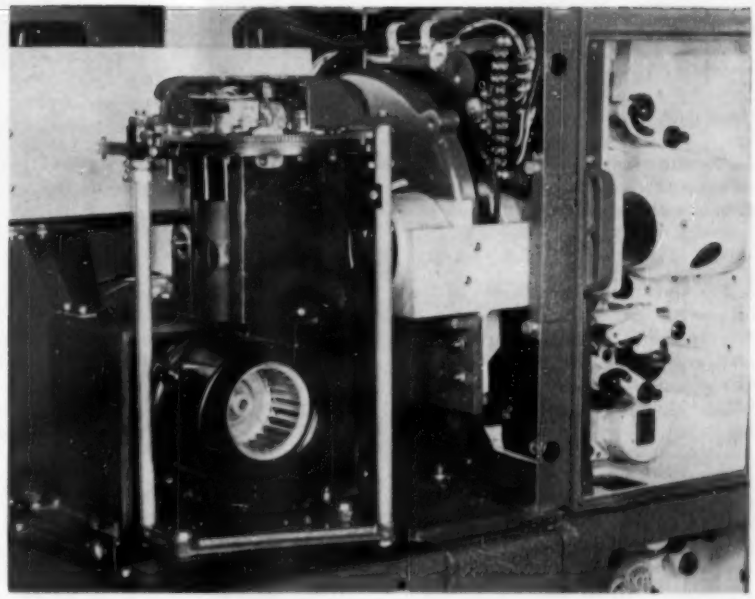

**Fig. 9. Light-intensity control mounted in an RCA TP-35CC Projector.**

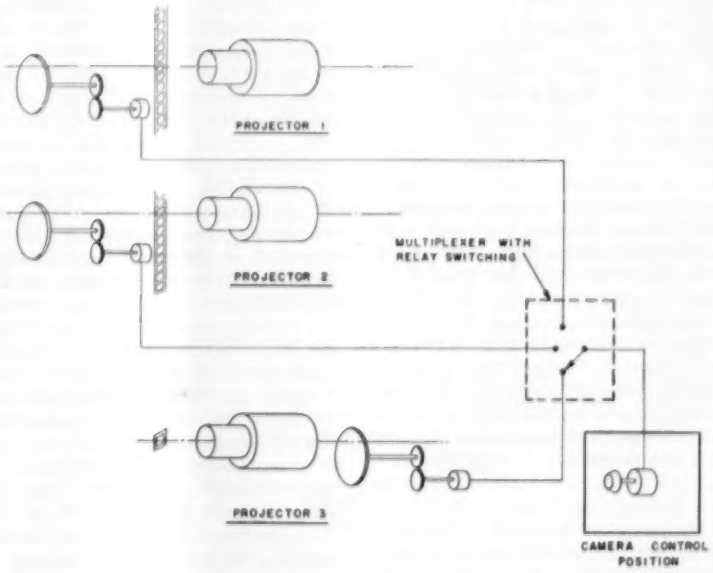


**Fig. 10. Multiplexer system for varying light controls.**

### General

New RCA TV projector designs include this control system as part of the projector (Figs. 8 and 9).

General practice has been to integrate two or more projectors into a film pickup system. Several types of multiplexers are available to perform this function of optical mixing. The RCA Multiplexer, designed to work with this equipment, performs the additional function of allowing switching between projectors from a remote point and operates the light-intensity controls from a single remote-control position usually conveniently located at the camera-control equipment.

With this type of installation the gain control of the Three-Vidicon Camera System actually is the light-intensity control of the projector. This and the master pedestal control are the only operating controls in the three-vidicon camera.

The present mode of operation uses one gain-control knob to vary a number of projectors (Fig. 10). Through relay switching provided in the multiplexer only one projector-light control at a time is varied from the camera-control position, this being the projector designated as "On Air" by the positioning of the optics in the multiplexers. The controls for the filter wedges on all other projectors are shorted to one end of the range, putting the filter wedges at maximum density. This was done so that in switching between projectors the filter wedge moves up from minimum light output to the control-knob setting.

The basic advantage of the system just described is that the operator has but one master gain-control knob to handle and switching of the control of this knob is handled automatically by the multiplexer.

Other systems have been proposed and investigated. One of these methods uses one gain control for each projector. This has a very distinct advantage over other systems in that it allows for setting up each projector on an individual basis through a preview arrangement. The projector is set up at the proper output level by previewing and when switching from one projector to the next via the multiplexer it will come into the system at the proper level without the necessity of having to adjust the gain control. The main disadvantage of this system is that the video operator must select the proper control knob after switching to another picture source.

### Conclusion

The vidicon tube, although a relative newcomer to the field of television film pickup equipment, has already proven itself in operation. This equipment has been designed so that still higher performances can be expected and obtained from film pickup systems employing the vidicon tube and light-intensity control of projectors.

### Acknowledgments

The authors wish to express their sincere appreciation to A. H. Lind and J. H. Roe of the Broadcast Studio Equipment Section, Engineering Products Div., Radio Corp. of America, Camden, N.J., for their cooperation in preparing this paper.

# A Note on the Estimation of Sodium Carbonate in Photographic Developers

By CHESTER I. POPE

**A procedure for the estimation of sodium carbonate in photographic developers to within ±1% is given. The carbonate is precipitated as barium carbonate and titrated with a standard acid solution.**

GASOMETRIC AND VOLUMETRIC methods of analysis are generally used for the determination of sodium carbonate in photographic developer solutions. Atkinson and Shaner[1] determined the carbonate in developer solutions by oxidizing the sulfite, acidifying, and absorbing the evolved carbon dioxide in a soda lime tube. The carbonate content was calculated from the gain in weight of the soda lime. This method is quite precise for the analysis of carbon dioxide but it requires special apparatus, and special precautions must be taken in making an analysis for carbonate in developer solutions. The titration methods, although simple, have the objectionable features that the titration must be made in the presence of sulfite and that any other alkali present will be titrated as carbonate. Atkinson and Shaner pointed out that if the developer solution is titrated with a standard acid solution to a pH of approximately 4.4 and if the sulfite content is known, the carbonate content may be calculated. Stott[2] described a method in which a known quantity of the developer solution is titrated with standard acid using a calomel and a platinum or glass electrode. The break in the curve (equivalence point) corresponding to the conversion of sodium carbonate to sodium bicarbonate is taken as the end point. Brunner, Means and Zappert[3] claimed that Stott's inflection point was not sharp due to the buffering action of the sulfite present and recommend titrating the developer solution to a pH of about 4 and calculating the carbonate content after making a correction for the sulfite.

The procedure described in this paper for the determination of sodium carbonate in developer solutions does not require special apparatus necessary in the gasometric methods of analysis and also eliminates the uncertainties involved in titrating a known volume of the alkaline developer solution with a standard acid solution. It has been used for an occasional analysis of carbonate in developer solutions and it is believed that the procedure could be adapted for control work. The carbonate and sulfite in the developer solution are precipitated as barium carbonate and barium sulfite, respectively. The precipitate is collected in a Gooch crucible, washed, and treated with hydrogen peroxide to oxidize the barium sulfite to barium sulfate. An excess of 0.1 *N* sulfuric acid is added to neutralize the barium carbonate and after digesting the solution on the steam bath the remaining acid is titrated with 0.1 *N* sodium hydroxide.

A contribution submitted October 8, 1954, by Chester I. Pope, Photographic Technology Sec., National Bureau of Standards, Washington 25, D.C.

### Procedure

Filter the developer solution before analysis. Add by means of a pipette 5.00 ml of the developer solution to a 400-ml beaker containing 25 ml of a 15% solution of barium chloride ($BaCl_2 \cdot 2H_2O$), stirring thoroughly with a glass stirring rod during the precipitation of the barium carbonate and barium sulfite. Immediately add 5 drops of a 0.1% phenolphthalein indicator and, if the solution is pink, titrate at once with 0.1 *N* hydrochloric acid until the pink color just disappears. Filter the solution containing the barium carbonate and barium sulfite precipitate through a Gooch crucible under reduced pressure. The asbestos mat in the Gooch crucible should be about 1 cm thick if the asbestos fibers are rather coarse but may be thinner if the asbestos fibers are fine. A porcelain or Witt plate is placed near the bottom of the asbestos mat. During the filtration the precipitate of barium carbonate and barium sulfite is transferred to the Gooch crucible, the beaker is washed four times and the washings filtered through the Gooch crucible. The precipitate in the Gooch crucible is finally washed four times. The total filtrate should be about 150 ml. The filtration should be slow enough to avoid drawing the fine precipitate through the asbestos mat.

After the filtration is completed, grasp the Gooch crucible with clean tongs, wash it on the outside with distilled water and transfer it to the same beaker in which the precipitation was made. The precipitate and asbestos mat in the Gooch crucible are covered with water and the mat and Witt plate are removed from the Gooch crucible with the stirring rod after several additions of water. About 75 ml of water are added during this operation. The Gooch crucible and Witt plate are not removed from the beaker. Add 15 ml of 30% hydrogen peroxide to the precipitate to oxidize the sulfite to sulfate and, after stirring, allow the admixture to stand about one-half hour. Pipette 50 ml of 0.1 *N* sulfuric acid into the beaker to neutralize the barium carbonate, stir thoroughly, cover the beaker and digest on a steam bath for two hours.

After the solution in the beaker has cooled to room temperature titrate the excess sulfuric acid with 0.1 *N* sodium hydroxide using 8 drops of 0.1% methyl red indicator. The color change of methyl red is red to white if the asbestos is dispersed in the solution, but the color change from red to yellow is discernible if the asbestos is allowed to settle after each addition of the sodium hydroxide solution. Calculate the amount of sodium carbonate in 1 liter of the developer solution using the following formula:

$$Na_2CO_3, \text{ g per liter} = (\text{ml } 0.1\ N\ H_2SO_4) - (\text{ml } 0.1\ N\ NaOH) \times 0.0053 \times 200$$

The 50 ml of 0.1 *N* sulfuric acid added to the barium carbonate precipitate in the above procedure is sufficient if the concentration of the sodium carbonate in the developer solution is not greater than 40 g per liter, but if its concentration is greater the developer solution to be analyzed must be diluted.

A blank must be run on the reagents and the asbestos and a correction made by subtracting the amount of 0.1 *N* sulfuric acid used in the blank from that needed to neutralize the barium carbonate in the above procedure. In this work the blanks did not exceed 0.2 ml of 0.1 *N* sulfuric acid. The asbestos must be white and free from acids, bases and other interfering substances. Distilled water in equilibrium with the carbon dioxide of the atmosphere was used throughout the procedure. The pH of the solution after the precipitation of the barium carbonate and barium sulfite should not be greater than 8; otherwise the carbon dioxide of the atmosphere will be appreciably absorbed and precipitated as barium carbonate. Generally the pH of the solution after precipitation is below 8 but, if not, titration of the solution with 0.1 *N* hydrochloric acid in the presence of the precipitate using phenolphthalein as indicator neutralizes the excess alkalinity giving a pH of approximately 8. Tests have shown that if the pH of the solution after precipitation of the barium carbonate and barium sulfite is 8 or less the amount of carbon dioxide absorbed from the atmosphere over a period of two hours does not interfere in this procedure. Hydrochloric acid was not used to neutralize the barium carbonate precipitate because of its

tendency to volatilize when the solution was digested on the steam bath.

If borate is present in the developer solution a small amount of it may precipitate as barium borate. If this is the case add 5 g of mannitol and titrate the excess sulfuric acid together with any boric acid present with sodium hydroxide to pH 7. Use a pH meter to determine the end point.

### Analyses

Sodium carbonate was prepared from ACS reagent grade sodium bicarbonate which was heated in an air bath for one hour at a temperature between 270 and 300 C. Weighed amounts of the sodium carbonate were dissolved in 20 ml of water containing 0.100 g of sodium sulfite. The above procedure was used for determining the sodium carbonate, except that the barium chloride solution was added to the sodium carbonate solution instead of adding the sodium carbonate to the barium chloride solution. The results are given in Table I.

**Table I. Results of Analysis of Sodium Carbonate Solutions in the Presence of Sodium Sulfite**

| $Na_2CO_3$ taken, g | $Na_2CO_3$ found, g | 3% correction, g | $Na_2CO_3$ calculated by adding 3% correction, % |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| 0.1688 | 0.1640 | 0.0049 | 100.1 |
| 0.1371 | 0.1322 | 0.0040 | 99.3 |
| 0.1900 | 0.1838 | 0.0055 | 99.6 |
| 0.1487 | 0.1453 | 0.0044 | 100.7 |
| 0.2130 | 0.2067 | 0.0062 | 100.0 |
| 0.1966 | 0.1919 | 0.0058 | 100.6 |
| 0.1824 | 0.1779 | 0.0053 | 100.4 |
| 0.2483 | 0.2418 | 0.0073 | 100.3 |
| 0.1551 | 0.1502 | 0.0045 | 99.7 |
| 0.1684 | 0.1624 | 0.0049 | 99.3 |

Column (1) shows the amount of sodium carbonate taken and column (2) the amount found. The sodium carbonate found is about 3 percent low and the deviations are not greater than ±1%. Column (3) in the table shows a correction value which is 3% of column (2). Column (4) gives the estimated value of sodium carbonate in percent calculated by adding the values in column (3) to column (2). The values in column (4) show that by adding 3% of the sodium carbonate found, the true sodium carbonate content may be estimated to within ±1%.

The procedure was used to determine the sodium carbonate in two solutions of sodium carbonate containing 10 and 40 g per liter, respectively, of sodium carbonate prepared as described above from sodium bicarbonate. By means of a pipette 5.00-ml portions were added to the barium chloride solution. Four analyses were made on each solution and the percentages of sodium carbonate found were in the range of 97 ± 1%.

The procedure has given consistent results to within ±1% in the analysis of sodium carbonate in developer solutions when the purity of the sodium carbonate added was known. For example two developer solutions were made up as follows:

| | |
|---|---|
| Metol | 1.56 g |
| Sodium sulfite | 22.5 g |
| Hydroquinone | 6 g |
| Sodium carbonate, anhydrous | 40.000 g |
| Potassium bromide | 0.95 g |
| Water to make | 1000 ml |

A third developer solution was made up the same as above except that the metol content was increased to 6.00 g. The developer solutions were analyzed for sodium carbonate content and, after making the 3% correction and also correcting for the carbonate neutralized by the metol, the percent sodium carbonate accounted for was 99.7, 98.9 and 99.8, respectively. A correction should be made for the amount of carbonate neutralized by the metol (*p*-methylaminophenol sulfate). One gram of metol theoretically neutralizes 0.3078 g of sodium carbonate. However, any correction for carbonate neutralized by the metol or other acid salt of a developer containing amino groups would be necessary only when analyzing developer solutions of unknown composition, such as packaged developers, to determine the amount of sodium carbonate originally added. In this case it would be necessary to identify the developing agents and determine those present in the form of their acid salts.

### Summary

The procedure may be used for the estimation of sodium carbonate in new or used developer solutions. Even if the correction factor were ignored, the accuracy would be sufficient in most cases. The necessary apparatus is simple. The carbonate and sulfite are precipitated and filtered as the barium salts thus eliminating the organic developing agents and other compounds which interfere with the titration of the carbonate. The precipitate of barium carbonate and barium sulfite is treated with hydrogen peroxide which oxidizes the sulfite to sulfate making it possible to determine the carbonate by neutralizing it with an excess of sulfuric acid and back-titrating the remaining acid with sodium hydroxide using methyl red as indicator.

### References

1. R. B. Atkinson and V. C. Shaner, "Chemical analysis of photographic developers and fixing baths," *Jour. SMPE*, **34**: 485–523, May 1940.
2. John G. Stott, "The application of potentiometric methods to developer analysis," *Jour. SMPE*, **39**: 37–54, July 1942.
3. A. H. Brunner, Jr., P. B. Means, Jr., and R. H. Zappert, "Analysis of developers and bleach for Ansco Color Film," *Jour. SMPE*, **53**: 25–35, July 1949.

FINAL INSTALLMENT

# History of Sound Motion Pictures

By EDWARD W. KELLOGG

**For the abstract of this paper which was presented on May 5, 1954, at the Society's Convention at Washington, D.C., see the first installment published in the June Journal. The second installment appeared in the July Journal. See p. 437 for errata in second installment.**

### Developments Which Extended the Frequency Range

*Better Light-Modulating System for Variable Area.* Mention was made in the section on loudspeakers of a demonstration by Dimmick and Belar[179] of sound with extended frequency range. Aside from the improved loudspeakers and the ribbon microphone (whose response was practically uniform from 60 to 10,000 cycles) there were a number of advances that contributed to the result. The new galvanometer and optical system made so much more light available that it was feasible to reduce the width of the recording beam to $\frac{1}{4}$ mil, thus improving resolution. No small factor in giving clean high frequencies is avoidance of flutter, particularly rapid flutter such as 96 cycles. In the demonstrations, both recording and reproduction were on magnetic-drive machines.* (The rotary stabilizer was not yet available.)

Ground-noise reduction was by galvanometer bias with a single narrow line of transparent film when the modulation was zero, and it is my recollection that a measurement indicated a ratio better than 50 db between signal at full modulation and the ground noise when biased for zero modulation.

*Nonslip Printer and Improved Sprocket-Type Printers.* With the sprocket-type contact printers in almost universal use, a certain amount of slipping of the negative with respect to the print film is almost inevitable. The curvature at the sprocket compensates for a certain negative shrinkage at which the ratio of radii of the shrunk negative and unshrunk print stock is just equal to the ratio of their lengths. The sprocket diameter is designed to make this compensation correct for an average negative shrinkage, but it will be only approximate for negatives whose shrinkage differs from this assumed average. By mechanically stretching whichever film is shorter, two films can be moved together through an appreciable distance in perfect nonslipping contact. A printing system in which this was done was developed by the Technicolor engineers for their color transfer, but it was not used for sound prints. An extended investigation of the losses and irregularities in high-frequency response which result from slippage and imperfect contact during printing is reported by J. Crabtree in the October 1933 and February 1934 *Journals.*[332]

In 1934 C. N. Batsel described a nonslip contact printer[333] employing a principle proposed and demonstrated earlier by A. V. Bedford for a different application.[70,334] Bending a film stretches one face and compresses the other, and it is only necessary that the contacting surfaces of the two films be made equal. In the nonslip printer, the negative is rolled through the machine at fixed curvature, and the print stock (held against the negative at the printing point, where it is propelled solely by friction) is made automatically to assume the curvature at which identical numbers

April 8, 1930. A V BEDFORD 1,754,187

BELT OR STRIP DRIVING ARRANGEMENT

Filed Nov 3, 1927

Fig. 1

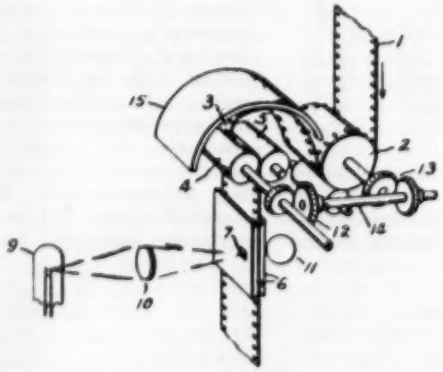


Fig 2.

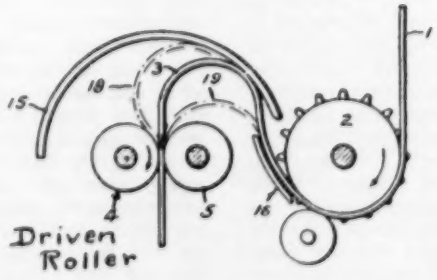


**Fig. 17. Control of film speed by flexure (A. V. Bedford). Principle later used in nonslip printer.**

* The special film-phonograph used in the demonstrations was a prototype of those used in the Disney *Fantasia* reproduction (see Fig. 7, p. 136, *Jour. SMPE*, Aug. 1941). The film was pulled by the magnetically driven drum over a curved supporting plate where the tracks were scanned, and was steadied at the other end of the plate by another drum with flywheel. This was an anticipation of the double flywheel system now used with magnetic tape and film.

of sprocket holes are fed through in a given time.

The nonslip printer was not built for sale by RCA, but free license and drawings were offered, and numerous laboratories built and used them, notably Consolidated Film Industries in Hollywood and Ace Film Laboratory in Brooklyn.[235]

A printer based on the identical principle was developed independently by R. V. Wood.[236]

Although nonslip printers were not made in large numbers, and did not to any great extent displace the conventional sprocket type of contact printer, they served to demonstrate how much improvement was possible through better printing, and in this way stimulated makers and users of sprocket printers to improve their machines and maintain them in the best possible condition. In a number of laboratories it appeared that better prints resulted if the teeth were removed from the side of the sprocket next to the soundtrack, leaving only a smooth supporting rim. The theory behind this is not clear unless it is that such disturbances of contact as are due to film sticking on the teeth are thus kept further from the soundtrack.

There were two reasons which limited the use of the nonslip printer. Since there is a very narrow region of close contact, the printing beam had to be narrow. Under such conditions any speed irregularities cause variation in print exposure, which sometimes becomes audible in density prints. While there is no valid excuse for such speed variations, this trouble contributed to the conclusion that the nonslip printer was unsatisfactory for density printing. Film laboratory operators were naturally averse to maintaining one type of printer for area and another for density. A more fundamental fault of the nonslip printer in making density prints is due to the fact that negative and positive perforations are not maintained in register. The more active developer circulation close to sprocket holes tends to darken these areas, resulting in a slight 96-cycle hum. The effects on the negative and print are compensatory provided the printing is done with the holes in registration, but cumulative if out of register. With a purely friction drive at the printing point the relative positions of positive and negative perforations are unpredictable and may drift slowly between one condition and the other. This results in a hum that comes and goes and is therefore more conspicuous than if steady. Area tracks are far less sensitive to such development variations.

Optical printers with independent filtering of negative and positive film motion would be subject to the same uncertainty with respect to relative perforation positions, but this problem comes up only with 35mm-to-35mm printing, for which optical printers are rarely used.

In spite of such improvements as have been made in developer turbulation in the processing machines, the sprocket type of printer does not appear to have any strong competitor for density prints. In such a situation the efforts of several Eastman engineers[112,113] to improve sprocket action are well justified. The shrinkage-compensating sprocket described above under "Mechanical Systems" should result in great improvements. The new film-base materials with their reduced shrinkage should also make for better results with printers of the sprocket type.[201]

*Optical Printers.* Cost and quick production have been dominating considerations in much 16mm production, and contact printing on the sprocket has prevailed, the printers being simpler than other types and available in large numbers to meet the heavy wartime demands. However, registration of negative and positive perforations is not a factor in the quality of 16mm prints of either density or area tracks. There is thus no obstacle on this score either to nonslip printers or to optical printers with independently filtered film motion, and both types have been used, the nonslip for printing from 16mm negatives, and the optical principally for printing on 16mm film from 35mm negatives,[237–239] but also with a 1 : 1 optical system for printing from 16mm negatives (Precision Film Laboratories, New York).[240]

The Eastman Co. has designed several models of optical reduction printers in which the 35mm and 16mm films are on sprockets on opposite ends of a single shaft and a U-shaped optical system is employed.[241] This system minimizes chances of slow "wows," but depends for good results on the degree of excellence attainable with sprocket action. The shrinkage-compensating, radial-tooth sprocket described in the section on "Mechanical Systems"[113] was developed with printer applications particularly in view.

### Ultraviolet Light for Recording and Printing

For truly distortionless recording the ideal light spot would be of infinitesimal width. In practice, as various improvements made light of greater intensity available, the nominal width of the recording spot was reduced (to 0.00025 in.), but a limit is set by diffraction. With light of shorter wavelength lenses of the same dimensions can form a more nearly perfect image. This is one of the considerations that led to a study by Dimmick of the possibilities of recording with ultraviolet light. Even more important than the improved image definition was the fact that ultraviolet light is more rapidly absorbed in the emulsion than is visible light. The increased absorption must be compensated for by increased intensity, but the net effect is that the exposure is confined more nearly to the surface where the silver halide grains are more completely used, and the result is less graininess. Most important of all is that the light scattered by the emulsion does not spread as far sidewise, and thus enlarge the image, as does visible light.[242,243]

Dimmick reported the results of tests with ultraviolet in August 1936.[244] He had found it possible to obtain adequate exposure with the regular incandescent lamps and Corning No. 584 filters.

Conversion for ultraviolet recording involved provision for the filter, redesign of the objective lens, and substitution of glasses with less ultraviolet absorption for other lenses in the system. Many of the variable-area recording systems were converted. Single-film newsreel systems (with the sound recorded on panchromatic negatives) were especially benefited by use of ultraviolet.[245,246]

The results obtainable by the application of ultraviolet exposure to variable-density films were studied and reported by Frayne and Pagliarulo in June 1949.[247] They found major improvement in definition and reduced distortion, but only about 1 db reduction in ground noise. Further experiences with ultraviolet are reported by Daily and Chambers.[248]

Many printers were modified to print sound with ultraviolet. High-intensity mercury arc lamps were widely used for the printers.

Ultraviolet exposure gives lower gamma for the same development than does white light. Advantage has been taken of this in certain cases of density recording to reduce the gamma of the sound print without departing from optimum development for the picture.

*Coated Lenses.* Each time any optical or light-source improvement made an increase in image intensity possible, the benefit could be realized in terms of finer resolution and better high-frequency response.

When the results were published of some tests in which the reflection from glass surfaces had been materially reduced by applying quarter-wavelength coatings of certain low-index minerals,[249] Dimmick procured equipment, mastered the techniques of applying such coatings by evaporation in vacuum, and compared the merits of various materials and methods of hardening the deposited layer. Having found a satisfactory procedure, he treated all the glass-air surfaces in the RCA recording optical system. Although the loss at each glass-air surface is only about 5%, there are sixteen such surfaces (excluding the

lamp bulb), and by reducing each to a magnitude of between 1 and 2%, a gain of more than 50% was possible in the brightness of the image on the film. Not only is the image thus brightened, but the stray light due to "lens flare" is reduced to a small fraction of its previous magnitude. A review of the subject, containing further references, has been published by W. P. Strickland.[250]

The first RCA coated-lens optical system to be field-tested was a "variable-intensity" system taken to Hollywood by Dimmick early in 1938 and used experimentally during some months at the Fox studios, C. N. Batsel being the RCA liaison engineer.[251] I believe that I am right in saying that the demonstrations of this system were partly responsible for arousing interest in the benefits to be had by such treatment of glass surfaces.

Within a short time the lenses in a number of the RCA recording systems were given low-reflection coatings, and the practice of coating lenses in both area and density recording systems spread rapidly.[252]

*Dichroic Reflectors.* As a by-product of the work on low-reflection coatings, Dimmick studied multilayer coatings of alternate high- and low-index materials.[253] With these he was able to produce plates having very high reflectivity in one part of the visible spectrum and very high transmission in another (65% reflection at 7500 A and better than 95% transmission between 4000 A and 5000 A).

The first motion-picture application of his "dichroic reflector" was for reflecting the red light of the recording light beam to a caesium phototube for monitoring, while losing practically none of the blue and violet light that produces the exposure.[254]

During the war there was heavy demand for dichroic reflectors, designed to various specifications, for the armed forces, and also great demand for low-reflection treatment of many optical devices. Selective reflectors of this type have also played an important part in color-television developments.[255]

*Heat-Transmitting Reflectors.* Another outcome of the development work on dichroic reflectors is a design in which the transition from high to low reflectivity occurs just beyond the end of the visible spectrum, so that as a mirror it would compete well in efficiency and whiteness with the best silver or aluminum mirrors, while the invisible heat rays are better than 75% transmitted.[256,216] No comparably effective means of separating the useful visible from the infrared radiation has been hitherto available, and we may look forward to extremely valuable applications.[257,258]

**Measures for Reduction and Control of Distortion**

There is hardly space here to mention the many refinements, including principles of good design, by which distortion has been kept low in microphones, amplifiers, recording devices, optical systems and reproducing systems. We shall confine ourselves to discussing the sources of distortion associated with photographic soundtracks. These may be listed as:

(1) background noise caused by graininess (especially in density tracks) or by scratches or dirt in the track area (most serious in area tracks);

(2) noise (hum) and amplitude modulation resulting from sprocket hole proximity;

(3) fluttter or "wows;"

(4) high-frequency loss;

(5) irregular high-frequency loss, and modulation of recorded sound, due to printer defects;

(6) waveform distortion due to misalignment of the aperture (slit) either in recording or reproducing, and to uneven reproducing-slit illumination;

(7) waveform distortion and production of spurious tones due to nonlinear input-output relations (more frequent in density recording than in area);

(8) waveform distortion and production of spurious sounds due to finite width of the recording slit and image spread in the film emulsion (a problem in the area system); and

(9) distortion due to overloading.

Measures for improving sound records with respect to background noise are discussed in part under "Ground-Noise Reduction," but also include extreme care as to cleanliness (especially in processing), to hardening and lubricating (waxing) the film,[259] to maintenance of projector condition, and to the several expedients by which the maximum reproduced volume can be increased.

Fine-grain film has made perhaps the greatest single contribution to improvement in ground-noise ratio, especially for density recordings, but its benefits have been in so many directions that only the present topic heading (Reduction and Control of Distortion) seems broad enough to include it.*

Various developments which improved high-frequency response have already been mentioned, and to these should of course be added the use of fine-grain film. The topic "Improved Printers" has also been included in the section on better high-frequency response. Reduction of flutter is dealt with in the section on "Mechanical Systems." Analytical studies of the distortion that results from misalignment (or azimuth errors) of recording or reproducing slits in the case of area recordings, have been published by Cook[260] and by Foster.[261] In the case of density tracks the effect of misalignment is practically equivalent to widening the scanning slit, the results of which in terms of high-frequency loss are given in a paper by Stryker.[262] Both Cook and Foster have published analyses of the distortion in area recording due to slit width.[263,264]

Calculations of the distortion resulting from certain cases of uneven slit illumination and with several types of area track have been published by Cartwright and Batsel.[265] A test film has been made available for checking light uniformity.[266] It has a number of very narrow recordings of a tone in a series of positions across the track, and their relative outputs when played indicate light intensity at the corresponding positions in the scanning beam.

*Sprocket Holes and Irregular Development.* The proximity of sprocket holes to the soundtrack causes various difficulties. Mechanically the variations in stiffness of the film cause it to bend in a form resembling a polygon instead of a true circle.[262,267] This causes 96-cycle flutter, less perfect contact in printers, and 96-cycle modulation of high-frequency tones if optical systems have small depth of focus and are not exactly focused for the average emulsion plane. More serious from the sound standpoint is the effect of the holes on development.[268,269]

In film development there is always a tendency to nonuniform developer activity due to local exhaustion. For example, over and near a large dense area the developer is slightly weaker in its action than over the middle of a lightly exposed area, and this in turn is weaker than the average of the bath. If the partly exhausted developer as it diffuses out of the emulsion is not immediately carried away from the film by currents in the liquid, it may creep along the film surface and weaken the development in such areas. If there is little fluid movement except that caused by the travel of the film, the direction of travel is often evident from the appearance of pictures.[270,271] Circulation of the liquid is somewhat freer near the holes and edges of a film than elsewhere, and therefore the development and average density greater. This was discussed in connection with printers.

The irregular development troubles are reduced by very active stirring or turbulation of the developer while the film is passing through.[272] Improvements on this score are reported by Leshing, Ingman and Pier.[273]

Uniformity of development is further improved if the emulsion has such characteristics that its "gamma infinity" is only slightly higher than the desired gamma. Film manufacturers have been

* It has been said that the entire evolution of sound reproduction can be divided into two parts: (1) the learning how to make a noise and (2) the reduction of distortion.

successful in producing fine-grain emulsions which come much closer to this desideratum than earlier types.

*Waveform Distortions.* The sensitometric studies and analyses about which we have already spoken are a part of the large body of literature bearing on the subject of distortion of the nonlinear type in density soundtracks. There have also been a number of experimental studies reported in this *Journal* giving distortion measurements with both density and area tracks. Two of the earliest of these were by Sandvik and Hall (October 1932)[274] and by Sandvik, Hall and Streiffert, October 1933.[276]

One of the most effective measures for reducing such distortions (second in importance only to avoiding overload) is by the use of push-pull soundtracks, and this applies about equally to density and area systems, although the causes of their distortions (Nos. 7 and 8 in the list) are quite different.

Two systems of testing for distortion (one for area and one for density systems) have assumed great importance since their introduction for ascertaining optimum ranges of exposure of negatives and positives. These are known as the "cross-modulation"[176] and the "intermodulation"[277] tests, and will be briefly described.

*Overload.* Overload in any element of the entire sound system other than in the soundtrack (either in the original recording or in the re-recording) means that the system has not been properly designed. It is easy to say that the way to avoid distortion due to overloads is not to overload, but that is asking too much. The price in terms of reduced average level is from a practical standpoint excessive. The levels set in recording are a compromise between too low an average level (with ground noise therefore more conspicuous) and too many and too bad-sounding overloads.*

In sections to follow, a number of expedients are mentioned for compassing a wider range between background noise and maximum reproduced level. These devices may be used either to make the background quieter or the loudest noises louder, and if properly applied can accomplish the latter with reduced instances of soundtrack overload.

*Cross-Modulation Test to Determine Best Processing for Variable Area.* While the variable-area system is not critical to gamma product it is subject to distortion, particularly at high frequency, due to the spread of the exposure outside the area of the actual image, caused by the scattering of light in the emulsion. This image spread increases with exposure. The distortion is largely in the form of a change in average transmission when a high-frequency wave is present. It is often referred to as "zero shift." It was particularly troublesome in some of the earlier 16mm recordings. It is possible however, by selecting the proper printing exposure, to make the image spread in the print neutralize that in the negative.[278]

In January 1938, J. O. Baker and D. H. Robinson described tests and equipment which became the standard method for ascertaining the correct relative negative and print densities.[176] For 35mm tests a 9000-cycle tone is 100% modulated at 400 cycles, but there must be no 400-cycle component in current supplied to the galvanometer. For a given negative exposure and development, a series of prints having different black area densities are made. They are then reproduced and the magnitude of the 400-cycle output measured and plotted (in db below the 9000-cycle level, or other reference) as a function of print density. The curve goes through a sharp minimum at optimum print density. With a negative of greater (black area) density the optimum print density is found to be higher. One of the most frequent problems is to select a recording exposure which will give maximum (or at least satisfactory) cancellation of cross modulation, when printed for a certain desired print density (say 1.4 to 1.6).*

Experience shows that if the 400-cycle cross-modulation is 30 db or more below full modulation, the sound is satisfactory. In similar manner if the print exposure and development are specified, the optimum negative density can be determined. For 16mm processing control, a 4000-cycle tone is modulated at 400 cycles. In push-pull recording the cross-modulation in the two parts of the track largely cancel each other and tolerances are extremely broad.

At the 1954 spring convention Singer and McKie[278] reported good results with an electrical compensating circuit, so that cross-modulation can be practically neutralized when making direct positives. This involves determining what function of frequency, exposure and (possibly) amplitude comes nearest to expressing the magnitude of the cross-modulation products.

*Intermodulation Test for Variable-Density Control.*[277] In the June 1939 *Journal* Frayne and Scoville describe a test for control of variable-density processing. In the earlier years of recording, the conditions for linear relation between negative exposure and print transmission were figured out by conventional sensitometric methods, with correction for the ratio of projection (or semispecular) density to diffuse density. But this is tedious, and a testing system which duplicated soundtrack recording and reproducing conditions was found preferable. In 1935 F. G. Albin[279] described a dynamic check on processing which consisted in making several recordings of a tone, all at the same fairly low amplitude, with a series of increasing mean valve-ribbon spacings. Comparison of the relative outputs from the print showed whether the slope of the curve of print transmission vs. negative exposure was constant or not. This was something of a forerunner of the intermodulation test. In the latter a tone of 1000 cycles or higher is superimposed on a low-frequency tone of, say, 60 cycles. Normally the level of the high-frequency tone is 12 db below that of the low tone, and the combined amplitude just short of overload. The print is run through a reproducing system, and the reproduced high-frequency tone separated out and measured for fluctuations in amplitude. Nonlinearity (distortion) becomes evident as fluctuations of the high-frequency tone, in general at rates equal to the frequency of the low tone or multiples of that frequency.

*Fine-Grain Films.*[280–282] While the many components of sound recording and reproducing systems were being improved, the great film companies were busy. In the period 1930–1940, the Eastman Co. offered at least seven new emulsions,[282] each of which offered some advantages for soundtrack application as compared with the currently used picture positive (Eastman No. 1301). In 1932 Eastman brought out No. 1359, intended for variable-density recording It was however similar to No. 1301 in contrast. In 1936 No. 1357 was brought out for variable-area recording, slightly faster than No. 1301 without sacrifice with respect to grain and resolution. With ultraviolet exposure it proved popular for variable-density recording. For release prints, however, the positive No. 1301 continued the almost universal choice except as similar films of other manufacture were used.

What was primarily wanted was finer grain, for this would mean cleaner, sharper images for variable-area tracks, less background noise in variable-density tracks, and better resolution and high-frequency response in all tracks. But fine grain in general means lower speed, or more exposure required, and too great sacrifice in this direction would make new films unacceptable. Another difficulty was that with many of the earlier fine-grain emulsions the image had a

*Most movie fans have probably forgotten what a gun sounds like.

*This test is made simpler than it might appear by the fact that when a high-contrast negative is used, the print black-area density is scarcely affected by differences in the black-area density of the negative, hence the printer light setting can generally be kept the same for the entire series of negatives.

brownish tone, which was objectionable in the picture, and so ruled these emulsions out for the release prints. Measures were found for correcting this fault in Eastman fine-grain positive No. 1302. The problem of exposure was less serious in the case of fine-grain films for release and for duplicating than for recording stock, although some changes in printers were required. Special films were introduced about 1937 for duplicating purposes.[284]

One of the chief problems in variable-area recording was due to image spread (beyond the exposed area), but it was found possible to make image spread in the print compensate for that in the negative. The criticism of one of the trial emulsions intended for variable-area negatives (No. 1360) was that it was *too* good in this respect for the currently used print stock.

Re-recording is the universal practice. Graininess and other imperfections in the original negative are transferred to the print, passed on to the second negative by the re-recording operation, and in the final printing are added to the graininess of the release print. The use of direct positives offered promise of eliminating at least one step which was contributing its share of noise. In 1937 Eastman introduced its No. 1360, and Du Pont its No. 216, both fine-grain films designed for making variable-area direct positives.

Changing to a new release stock represented a greater hurdle than the use of special films for negatives and for the re-recording print, so the general thought was to evolve the best possible films for these applications, and take what improvement could be gained in this way. As the story turned out, use of the fine-grain films did not become general until they were used also for the final release prints.

Film graininess contributes to background noise in much greater measure in the density system than in the area system, but the requirements seem to have been harder to meet. Many tests were run and studies made during the years 1938–1940, and a special committee representing those particularly interested in variable-density recording reported in the January 1940 *Journal*,[289] in which tentative specifications were given to guide in the development of the needed fine-grain films.

Du Pont No. 222 was one of the first fine-grain films to gain considerable acceptance, especially at the M-G-M and Paramount studios, where it was used for original negatives, re-recording prints, re-recorded negatives and for a limited number of release prints. High-pressure mercury lamps were substituted where needed to give the required printing exposure. Experience at the Paramount studios is reported by C. R. Daily in the same issue.[286] Figures published in these reports indicate that while a re-recording print might be 8 to 12 db better in signal-to-noise ratio than one made on the previous types of film, only 4-to-6 db net gain was to be expected in the release print if this were on the usual stock. This indicates why the real gains from use of fine-grain film were not achieved until they were used for the release prints as well as in the earlier stages. (See also references 287–290.)

Some difficulty was encountered in processing the negatives to a suitably low gamma, but it was accomplished by use of special developers. (Uniformity of development is almost impossible if the time is cut so short that the gamma is far below the "gamma-infinity" for the given emulsion and developer.) In order to permit somewhat higher values of gammas in the fine-grain negatives the practice was adopted in some laboratories of holding down that of the fine-grain release prints by printing the sound with ultraviolet light, which gives lower gamma for a given development than does white light.

In 1938 the Eastman Co. brought out a high-resolution film (No. 1360) for variable-area recording and in 1939 a recording film (No. 1366) for variable density. In 1941 the No. 1302 fine-grain positive which has been widely used for release prints, became available. In 1945 the Eastman Co. brought out a high-contrast fine-grain film (No. 1372) for variable-area recording and a low-contrast fine-grain film (No. 1373) for variable-density recording, which could be processed in regular picture-negative developers instead of requiring special low-energy developers. The same year Du Pont brought out a new fine-grain recording negative (No. 236) for variable density, whose contrast could be more easily controlled than previous types because of low gamma infinity.

The fine-grain recording films are all much slower than the previous recording films, (No. 1302, for example, requiring about four times the exposure of No. 1301), and recording optical systems, although improved by coated lenses, could not with tungsten lamps provide sufficient exposures for the combination of fine-grain and ultraviolet light, but use of the fine-grain films with white-light exposure went so far in affording the benefits of high resolution and low noise that the combination seemed hardly needed. On the other hand, printing fine-grain positives with ultraviolet light from high-intensity mercury arcs has been widely employed.

It is of interest that the Callier coefficient (ratio of specular to diffuse density) is less with fine-grain than with coarser-grain films, and the result is that a higher control gamma (in which the measurements are of diffuse density) is needed to give the optimum picture on the screen—for example 2.5 for No. 1302 as compared with 2.1 for No. 1301.[290]

*Variable-Density vs. Variable-Area.*[291,292] The rivalry between advocates of variable-density and variable-area recording is nearly as old as commercial talking pictures and has unquestionably promoted progress in both systems. The fact that the industry did not standardize on one or the other track does not seem to have been any handicap, for all theaters could play either type of track.

During the earlier years of commercial sound, the advantage seemed to be on the side of area for music but density for speech intelligibility. With both at their best there was little to choose in clarity of speech reproduction, but the density system seemed able to take more abuse without too serious loss of articulation. Before control of zero-shift was well in hand (see cross-modulation test[276]) this type of distortion seemed to do more damage to the quality of the high-frequency reproduction than the nonlinearity to which the density system is more subject. With improved techniques and equipment this difference disappeared.

Another factor which for a time was prejudicial to the area system was that, as compared with density recordings, low-level passages seemed to be excessively weak when the controls were set for satisfactory normal and high-level passages. One theory was that, due to some fault in equipment or system, there was "volume expansion," or actual exaggeration of level difference. To those most familiar with area recording such a theory appeared untenable. Measurements did not bear it out. Monaural or single-channel listening itself makes level differences seem greater than direct binaural listening. Could it not be that the density recordings by their nonlinearity produced a compression effect? I recall that one of the most confident exponents of this explanation was M. C. Batsel. One of the fundamental differences in the systems is that an area track overloads very abruptly, whereas in a density track the upper and lower limits of light transmission are approached more gradually. With such a characteristic, considerable overload (i.e. beyond the range of true linearity) can be tolerated without too objectionable effect, and it was thought that considerable advantage had been taken of what might be called permissible overloading in the density recordings as compared with those made on the area system.

A nearly equivalent effect in an area recording can be obtained by rounding the corners of the V-shaped opening in the aperture plate (whose image is the light spot on the slit as shown in Fig. 13). Transition curves are introduced at the outer (full-slit illumination) ends,

while the vertex is drawn out to a finer point. Such curved apertures were tried and largely overcame the cause of criticism.

However, the use of electronic compressors (long employed in broadcasting studios) appeared preferable to sacrificing the range of low-distortion light modulation. Compressors were introduced in the recording channels with very satisfactory results. The first such compressors were tried at RKO and Warner studios and compression became the standard. If the original recording is on a wide-range (or low-background-noise) system, most of the compression is introduced in the re-recording to the release-print negative, but I am told that even with magnetic recording some compression is used (or at least available) in the initial recording.

Any simple and general statement of the relative signal-to-noise ratios of the two systems is impossible, since each has its own cause and type of ground noise: grain hiss in density, and ticks and pops due to dirt or scratches in the area system. Area starts with an initial advantage of about 6 db greater output, and if the film remains in good condition its signal-to-noise ratio is better. The variable-area system was chosen by the Bell Laboratories engineers for their stereophonic demonstrations.

As various improvements became available to the industry they worked to the benefit now chiefly of one system and now of the other. Fine-grain films helped both, but helped density more.

The higher output from variable-area tracks led to the proposal by Levinson[298] that intercutting of the two types of track be used as means for increasing reproduced volume range.

The RCA light-modulation system has been modified to record variable-density, by use of an out-of-focus image or "penumbra" on the slit in place of the usual sharply focused triangular spot.[193,294] This system modulated the light reaching the film by changing its *intensity*, whereas the light valve produced a spot on the film of constant intensity but varying height, and therefor varied the *time* of exposure.

The light valve also was modified to make variable-area records by turning it 90° so that the ribbons were vertical (parallel with the direction of film motion) and the motions of their edges imaged at 10 : 1 magnification on the film. This was the system employed for the stereophonic demonstrations.[295,295,296] Variable-area optical systems using light valves were shortly thereafter offered as optional equipment to licensees.

By using valves having one, two or three ribbons as needed, the light-valve system has been made to produce many of the various types of area track that are produced by the RCA galvanometer optical system by changing apertures.[193,194,297]

The strict adherence to one system (area or density) on the part of the major picture companies has in considerable measure broken down, and several are employing both systems, depending on the type of operation required.[299] For example M-G-M, while continuing to use double-width push-pull density for initial recordings,* releases on variable area. One of the reasons for changing to area for release prints is that projectionists often neglected to change their gain settings when switching back and forth between area and density tracks, with a result to the disadvantage of the film with lower output (note also interest in Perspecta Sound.)

Mention is made, in the discussion of control tones, of a system in which the control tone is of subaudible frequency and superimposed on the recorded sound. Modulation of the sound by the control tone is much more easily avoided in area recording.

*Compressors.*[299] In the previous section comparing the area and density systems, the first urgent need of electronic compressors was described, but their use has proved so advantageous as to have become quite general, both in recording and re-recording channels.[300] Electronic compressors had long been in use in radio broadcasting.[304,304a] In their application to sound recording, if there is no provision for re-expansion, they do not actually increase the reproduced volume range although they may seem to. A common characteristic compresses 20 db into 10 db at a uniform rate. This would rob any passage of expression only to a slight degree. As the overload point is approached it is common to make the compression more drastic, for example 20 into 3 db. This is sometimes called a limiter type of compressor. If (for example by means of control tone) provision is made for re-expansion, the compression may be such as to keep the loud passages, whatever their original magnitude, at nearly full track amplitude. (See section on "Stereophonic.")

Since initial consonants usually carry little power compared with vowels, the compressor may wait to act for the vowel, with resulting relative exaggeration of consonants (especially sibilants). This has been corrected by a high-frequency pre-emphasis in the modulation which controls the compressor.[301–303]

Anticipation in compressor systems is desirable (see section on "Ground-Noise Reduction"). Fast action of compressors is essential and avoidance of "thump" is one of the problems.[305,306]

Experiences in recording with compressors are reported by Aalberg and Stewart of RKO[300]. Experience with compressors at the Warner Bros. Studios is reported by B. F. Miller.[301]

*Squeeze Track.*[307] In view of the limited range of loudness which a soundtrack permits, and the very great range encountered in our ordinary experience, many expedients were tried for the purpose of increasing the range obtainable from the film. One of these was the "squeeze track" described by Wesley C. Miller of M-G-M.[307] If a variable-density track is reduced in width, both the noise and the modulation are reduced. The ground-noise reduction system described by Silent and Frayne in May 1932[188] may not have been as yet available, but the two devices are not equivalent and can be complementary. There is a practical limit set by film characteristics as to how far the ground-noise reduction, by reducing mean negative exposure, could be carried, and this was at about 10 db of reduction, but the noise can be still further reduced by narrowing the track. The controls in recording or in re-recording are used to avoid too low levels on the track, but some of the range can be restored by narrowing the track in the release print. There were several ways in which this could be done; one, for example, was by preparing a masking film and running the print through the printer a second time with the track width determined by the mask.

*"Reversed Bias" System.*[308] An expedient for obtaining greater output for bursts of high level sound was described by Hansen and Faulkner[308] of Twentieth Century-Fox. In effect the light-valve bias operates in the usual way for normal and low levels, but for passages of extra high level the mean ribbon spacing is increased to as much as twice normal while still being fully modulated. There is some resulting distortion, but substantial increase in print output. The loss of some relatively high-frequency output is probably not objectionable.

*Wide Track and Push-Pull.* By doubling the width of the track the noise would be expected to increase 3 db but the usefully modulated light would increase 6 db. While the improvement is not large, it is worth while, and has been widely employed for original recordings and for special purposes, when the sound print does not have to carry a picture.

Push-pull systems have also been developed for both density[309] and area[152] systems and for wide tracks[210,211] and standard-width tracks. Standard-width push-pull systems have been considered for general theater reproduction, but their actual use has been limited to places where the required special reproducing systems did not involve large investment. The push-pull system does not give any improvement in signal-to-noise ratio except for the few film

* Probably later adopted magnetic recording.

blemishes or other disturbances which affect the light through both sides alike. The principal advantage of the push-pull system is that it reduces distortion, and in the density system it may thereby somewhat increase the permissible ratio of light modulation. As applied to area recording it almost eliminates zero-shift distortion. With both systems, push-pull operation permits the use of faster-acting ground-noise reduction, since the "thump" caused by rapid change in transmitted light is largely cancelled. Milestones in the progress toward better sound are usually fixed in our minds by major demonstrations. Such a demonstration was given at the 1935 spring convention. Using wide-track push-pull density recordings, improved two-way (divided-frequency-range) loudspeakers and amplifiers with abundant reserve power, the engineers of the M-G-M Sound Department, under the direction of Douglas Shearer, gave impressive demonstrations.

Push-pull wide-track is regarded as the last word in photographic recording and has for years been used in many studios for original recording.

If the original recording is wide-track push-pull, the positive (which is edited and then used as the master for re-recording to the release-print negative) would be a print of the original. If the original is magnetic, the favored practice has been to re-record to a wide-track push-pull direct positive for the edited film. In eliminating the step of printing, the direct positive minimizes quality losses.

*Control Tone.*[312] The most effective way to reproduce the great range of sound volume encountered in natural sounds is to resort to compression for the recording and to expand in reproduction. It has always been the practice for the recordist to use his controls to maintain the recorded levels between the limits set by overload and a satisfactory margin above noise. Were a record made of each change in recording gain, and the projectionist given a cue sheet by which he could at the right times make the inverse changes in reproducing gain, the natural levels could be restored. Such a method of operation was at one time contemplated. However, manual controls in recording are too slow, and manual restoration of level too unreliable. Automatic control of gain on the other hand has been used very effectively. If space can be found on the film for an extra soundtrack, a continuous tone can be recorded with either its amplitude or its frequency automatically correlated with the gain of the recording amplifiers, so that it provides a complete record of the recording gain throughout the recording.

For example, a voltage derived from the modulation to be recorded (and thus a function of its initial level) can operate on the recording amplifier to change its gain as in any automatic compressor, and the same voltage can operate simultaneously on the control tone to make the appropriate change in either its amplitude or frequency. In reproduction the output of the control-tone track is then used to provide a voltage which is directly related to that which altered the recording gain, and can therefore be used to produce inverse, or compensating, changes in the reproducing gain.

The use of an extra soundtrack or recording to be used in the manner just described was, I believe, first proposed by C. F. Sacia of the Bell Laboratories, and described in U.S. Pat. No. 1,623,756. One of the first in the RCA group to become interested in control tones was Charles M. Burrill who experimented with tones superimposed on the modulation, but of either too high or too low frequency to be reproduced by the audio system, especially a subaudible tone such as 20 cycles. For film recording he proposed scanning the sprocket-hole area, and varying the magnitude of the resulting 96-cycle tone by blackening more or less of the film between perforations. Thus, if these areas are left clear, the 96-cycle tone is comparatively feeble, while the maximum is produced if they are black.

The sprocket-hole control track was developed for application by H. I. Reiskind and adopted by Warner Brothers for their "Vitasound" system, which will be described in the section on multiple-speaker systems.[308]

Control tones of the subaudible type have in recent years found use for producing spread-sound and stereophonic effects which are particularly appropriate for accompanying large-screen pictures. (See Perspecta Sound, under "Multiple-Speaker Systems" below.) The chief advantage of this method of recording the control tones is that it requires no changes in the recorders and scanning systems, the changes being confined to the electrical circuits. It meets the important practical requirement that reproduction must be acceptable on standard equipment (with no provision for control-tone use). Variable-area recording is better suited than variable-density for use with subaudible control tones, since with suitable processing more accurate linear relationship between input and output can be maintained throughout the range of modulation, thus avoiding modulation of the audio by the control tones. The maximum level which can be recorded must be reduced 2 or 3 db, to make room for the control tones, so that the sum of the two will not exceed the permissible maximum. Tones of 30, 35 and 40 cycles have been used for the controls.

A control-tone system used by adherents of the variable-density system was described by Frayne and Herrnfeld.[313] Between the normal soundtrack and picture areas, space was found for a soundtrack 0.005 in. wide. The authors give their reasons for believing that frequency modulation of the control tone would be more reliable than amplitude modulation. With a frequency range of one octave and using a bandpass filter, they found that in spite of the narrowness of the track it provided a 38-db signal-to-noise ratio. The system was designed to afford changes of gain for the sound up to 30 db, thus expanding the dynamic range by that amount. The soundtrack was of the standard-density type.

In certain systems in which three or more independently recorded soundtracks are used, the sound and picture are on separate films. This gives plenty of room for the control track, but the practice has been to allot only one track to the control and to superimpose the tones, separating them in reproduction by bandpass filters.

*Class B Push-Pull.* Of the possible systems of photographic recording, the Class B area track undoubtedly carries furthest the principle of low print transmission when the modulation is low. Such a system was described by Dimmick and Belar in 1934,[314] and favorable experience in its use was reported in 1939 by Bloomberg and Lootens of Republic Pictures,[315] where it had been adopted for original recordings and been used in the making of fourteen pictures at the time of the report. They have continued to the present time using the Class B push-pull system for all original recordings. They also reported the methods used for test and adjustment. In the Class B system one side of the track carries only the positive parts of the waves and the other only the negative. When there is no modulation there is no clear film, and no ground-noise-reduction system is needed; therefore the transient or initial clipping which ground-noise-reduction systems can produce are avoided. Two triangles of light (see Fig. 13) are formed at the plane of the slit (one for each half of the track) and their vertices just touch the slit with no current in the galvanometer. Exposure takes place only as one or the other triangle illuminates more or less of the slit. A feature not described in the papers just mentioned is shown in a September 1937 paper by Dimmick.[183] In the mask which is imaged at the plane of the slit to form the triangular light spots, a narrow slit extends from the vertex of each triangular opening, so that light is never completely cut off at this point. There is thus formed a continuous line at the middle of each half track, not wide enough to let an appreciable amount of light through the film, for it is so narrow that it is

largely fogged in, but it prevents a slight wave-shape distortion which might otherwise be produced by image spread, just as the tip of the triangle crosses the slit.

*Direct Positives.* Recording direct positives, instead of recording negatives and then making prints from which to make re-recordings, would seem to offer important advantages in simplifying operations and reducing time loss. There would also be an advantage in reduced ground noise since one less film is used and thus one less source of graininess. The high-frequency losses due to the printer would also be avoided. In the section on "Ground-Noise Reduction," it was stated that a ground-noise reduction system applicable to variable-area direct positives had been developed with the feature of anticipation, so that initial clipping need never occur. It was further possible under these conditions to work with closer margins, and so reduce the width of clear film. This system and results of tests with it are described by Dimmick and Blaney in 1939,[199] with a further report by Blaney in 1944.[316]

The chief obstacle to making variable-area direct positives had been that an entirely satisfactory way of avoiding distortion due to image spread had not been found. In the negative-positive process image spread in the negative could be compensated by that in the print, but the direct-positive system left no place for that solution. There is, to be sure, a certain density for any film at which there is no image spread, and below which the blackened area is slightly less than the exposed area. With the recording films available for a number of years, the density which gave no spread, or zero shift, was so low that light passing through the darkened areas would result in considerable noise. In some of the later fine-grain recording films, however, the balance occurred at densities which were satisfactorily high, thus making direct positives feasible under conditions in which they had not been before. However, the direct-positive system described by Dimmick and Blaney was not limited to the use of special films. They used a push-pull system which goes so far toward neutralizing the effects of image spread that excellent results were obtained with the standard fine-grain recording stock for variable-area.[316,317]

In variable-density recording the same anticipation feature is not applicable, but the other advantages of direct positives for original recordings apply. The problem of recording a positive lies in the requirement that the film transmission shall not be a reciprocal of the exposure (hyperbola) which a non-reversing film tends to produce, but must have an inverse relationship expressible by a downward-sloping straight line, covering a large range of transmission. A method of correcting *in the reproduction* for the nonlinear transmission characteristic of a variable-density negative was described by Albersheim in 1937,[318] but this would limit the usefulness of the direct positives. Electrical compensation in the recording was described by O. L. Dupy of M-G-M in 1952.[319] An approximation to the desired relation is possible by recording on the toe of the H&D curve, but high-level output is not possible from such direct positives without serious distortion.

A radically different solution of the problem was described by Keith and Pagliarulo in 1949.[320] Superimposed on the audio current supplied to the valve was a 24-kc bias current of twice the magnitude required to modulate fully the light-valve opening at normal unmodulated spacing. The ribbons are in different planes so that they can overlap without clashing. The authors reported 8-db higher output from the direct-positive than from a standard-density print, and 6-db higher signal-to-noise ratio than a standard print without ground-noise reduction. Direct positives, generally push-pull, have come into wide use for editing and re-recording service.[321,322]

*Electrical Printing.* Successful recording of direct positives opens the way to "electrical printing," or putting soundtracks on release prints by a re-recording operation instead of by contact printing. This is discussed by Frayne.[323] While such a method would necessarily be more expensive, the elimination of the flutter and irregularities resulting from the action of most contact printers is a strong argument in its favor. Frayne finds possibilities of greatly improved sound by this method, particularly for 16mm color prints of the reversible type such as Kodachrome or Ansco-color.

Engineers have long been attracted by the possibility of improved resolution and reduced distortion in 16mm positives by direct recording,[324] but until the more recent developments, direct positives (except on reversal films) were not a success.

*Limits of Volume Range.* While ideal sound reproduction would seem to call for duplication of original sound levels it is questionable whether illusion or seeming naturalness is improved by going as far as this in the direction of loudness. In the applications of control-tone systems, where very high levels are attainable, the extremes have been scaled down by 10 db or more. With respect to the desirability of carrying reproduction to extreme low levels, W. A. Mueller[325] has shown that there is a definite practical limit set by general theater noise.*

**Multiple-Speaker Systems**

It has often been observed that musical reproduction gives greater satisfaction if it comes from several sources. The Music Hall at Radio City in New York has been equipped to make this possible, and thus has afforded numerous opportunities to verify the advantages of multiple sources. With reference to the effort to obtain "dynamic range," Garity and Hawkins[233] state that: "Three channels sound louder than one channel of three times the power-handling capacity. In addition, three channels allow more loudness to be used before the sound becomes offensive, because the multiple source, and multiple standing-wave pattern, prevents sharp peaks of loudness of long duration."

That dialog should be reproduced on a speaker as near as possible to where the actors are seen is never questioned, but music and many sound effects such as thunder, battle noise and the clamor of crowds are far more impressive and natural if coming from sources all around the listener. The effects obtainable are discussed by H. I. Reiskind[326] who also describes the equipment used in the sprocket-hole control-track system.

*Vitasound.* This system, used by Warner Brothers, is described by Levinson and Goldsmith.[327] It is the simplest of the systems employing spread-sound sources and control tone. It uses three similar loudspeakers, the usual screen-centered dialog speaker and two side speakers outside the screen area. The design of the system is based on the theory that the volume range which the film (with the usual ground-noise reduction) affords is adequate for dialog and such other sounds as come from the center speaker only, and that higher sound levels will be wanted only for music and sound effects for which the spread-sound source will also be wanted. The control-tone output is therefore used, first to switch in the side speakers, with no change in total sound power. Further increase in control-tone output raises the gain on all three speakers, up to a total of 10-db increase.

*Stereophonic Sound.* Mention has been made in the section on loudspeakers of the transmission of music and other sounds "in auditory perspective" from Philadelphia to Washington in 1933. Three microphones were spaced across the stage and their outputs separately transmitted to three similarly located loudspeakers at the auditorium where the sound was reproduced. The various

* Background noise makes the useful sound seem fainter than sound at the same level in a quiet place. This holds even though the background noise is not loud enough to interfere nor even to make the listener conscious of its presence.

orchestral sounds seemed to come from the appropriate places, and a moving source such as a man walking across the stage and talking seemed at the receiving end to move about. In 1941 and earlier,[328,329] similar demonstrations were given, with the difference that this time the sound was recorded and reproduced. As in the previous case, every effort was made by the engineers of the Bell Telephone Laboratories and Electrical Research Products Inc. to minimize all forms of distortion and to reproduce the sound in the full dynamic range of the original.

Since it appeared that for the immediate purposes of the project the films could be maintained in good condition with respect to abrasions and dirt, and that under such conditions the advantage in terms of signal-to-noise ratio is with the variable-area system, the recordings were of the variable-area type, made with an adaptation of light-valve optics. The recorder and reproducing machine carried the film through the translation points on smooth (toothless) drums, on whose shafts were damped flywheels of the liquid-filled type described by Wente and Müller.[81,104]

On the basis that the film track was capable of giving a signal 50 db above noise, while the orchestral music to be reproduced had a range of 80 db, compressors were used in recording, and expandors in the reproducing system designed to compensate exactly* for the compression in recording. The compressors made no change of gain until the signal neared full track level and above this made the gain the inverse of the sound level, thus keeping the recorded level just below track overload. The level of the amplified microphone output controlled the magnitude of an oscillator tone, which tone was simultaneously recorded in a fourth track and applied to the recording-circuit compressor. In reproduction the same tone controlled the expandor gain. Because the levels at the three microphones did not necessarily rise and fall together, the compressors in the three channels were independently controlled by their own modulation levels. This necessitated use of three control tones, but these were recorded superimposed in one track and separated in reproduction by filters.

In order to give the compressor time to operate when a sudden increase of sound level occurred, an "anticipation" system was employed, using two microphones. The compressor operation was determined by the output of the microphone closer to the source, while the second microphone furnished the sound to be recorded.

As further insurance against audible background noise, the system of "pre-emphasis and post-equalization" of high-frequency components of the sound was employed. The usual ground-noise-reduction system by light-valve bias was not used, being made less necessary by the compressor-expandor (or "Compandor") system.

The October 1941 issue of the *Journal* carries discussions by Fletcher,[223] Steinberg,[330] Snow and Soffel,[331] Wente and Müller,[104] and by Wente, Biddulph, Elmer and Anderson,[332] of various aspects and elements of the stereophonic system.

Despite the unquestionable success of the stereophonic system in reproducing the subjective effects of sounds coming from the sources located as seen on the screen, and the impressiveness of the musical and sound effects which it was capable of handling, the motion-picture industry made no immediate move to adopt or apply it. A factor which undoubtedly militated against interest in utilizing the stereophonic system was that only for the patrons near the front of a theater did the screen subtend a large enough angle to make the difference between stereophonic and single-channel reproduction impressive. It appears to be another case of a development ahead of its time. With the recent advent (commercially) of the wide-film systems CinemaScope and Cinerama, stereophonic sound, supplemented by "spread sound," plays an essential role in providing the desired overall effects.

*Fantasound: Fantasia.* Walt Disney and his engineers had a somewhat different idea of what might be accomplished by means of multiple-track recordings with control tones. It might be appropriate to say that they proposed to make their spread-sound effects an art rather than a science. Duplication of an original distribution of sound sources was a secondary consideration, and the choice of directions from which sounds were to come was to be entirely at the discretion of the directors, musicians and technicians.

The story of the development of Fantasound and its evolution through numerous experimental forms beginning in 1937, was told by Garity and Hawkins,[333] with further reports by Garity and Jones,[334] and by E. H. Plumb.[335] Garity and Hawkins reported from tests that if a sound source (from loudspeakers) was to seem to move smoothly from one position to another, the output power from the two speakers should be held constant. This condition is not necessarily met by having the actual source move from near one microphone to near the other, but it can be met when the gain is reduced to one speaker and increased to the other by means of a knob or control tone.

The animated picture was designed specifically for the music, which was taken from great classics. In the initial orchestral recordings many microphones and separate recording channels were used. Recordings were selected or mixed in the re-recording to obtain desired effects such as predominance in turn of various orchestral groups (strings, brass etc.). Sound and picture were on separate films. The final sound film carried three 200-mil push-pull variable-area soundtracks, and three superimposed variable-amplitude control tones on a fourth track. The amplitude of the several control tones was determined by manual adjustments.

The theater equipment consisted of three loudspeakers at the center and to the sides of the screen and additional speakers at the sides and back of the auditorium. The latter could be brought into operation by relays responsive to notches in the edge of the film. They were used effectively for various sound effects and for the music of a large chorus. Abundant sound power and volume range were employed, the volume range being readily obtained by use of the control tracks.

The final Fantasound equipment was designed by RCA engineers. A special optical printer was used to print sound from separate negatives onto the multitrack positive, and special film phonographs in which a single system illuminated all four tracks, the transmitted light being received by four independent double-cathode photocells.

*Fantasia* was enthusiastically received but was not a financial success because of the heavy expense not only of its production but of "road-showing" with such elaborate equipment. The advent of World War II hastened its withdrawal, but Disney had performed a great service to the industry and art by pioneering in a sound-effects field which is now finding important applications.

*Recent Multiple-Channel Systems.*[336–342] During 1952 and 1953 three new systems of presenting pictures were introduced, known as "3-D" (Three-Dimensional), "Cinerama" and "CinemaScope." All of these represent more elaborate and expensive picture-projection systems, and with them would logically go whatever could be offered in the way of more impressive sound. The principles of stereophonic sound, plus the surround speakers distributed around the auditorium (as used in Fantasound), have been applied.

In the 3-D system two projectors are required, and a third synchronized machine, a film phonograph, is added for the sound. The sound system is stereophonic and uses three 200-mil magnetic tracks.[370,371]

The CinemaScope system[339] (developed by Twentieth Century-Fox) presents a much wider screen picture than does the

* Exactly, in terms of timing, but not necessarily fully restoring the 30 db of compression range.

standard system, and therefore presents an excellent opportunity for the use of stereophonic sound since the screen speakers are distributed over a large enough distance to make the shifts in the position of the sound source noticeable and needed for realism. The sound system developed to go with CinemaScope uses four magnetic stripes or tracks, two just inside the sprocket holes and two outside. To make more room for the tracks and leave as much as possible for the picture, sprocket holes of new shape have been designed. In the new perforation no valuable feature is believed to have been sacrificed, and the film will still run on standard sprockets. Three of the tracks provide the regular stereophonic sound (three speakers behind the screen) and the fourth carries sound effects for transmission by the surround speakers. For multitrack magnetic reproducing equipment see references 108–110.

Cinerama[340] (developed by Fred Waller and Hazard E. Reeves, and commercialized by Cinerama Productions Corp.) carries the wide-screen principle much further, employing three projectors to project adjacent edge-blended pictures on a curved screen. For the sound six magnetic tracks are used, and five speakers behind the screen, while the sixth track feeds a set of surround speakers.

The surround speakers, wherever these are used, are of the direct-radiator type, much less bulky than the screen speakers and with more limited frequency range.

*Recent Multiple-Speaker Systems With Photographic Track.*[339] A simpler multispeaker (or sound-placement) system has been developed by Robert Fine[342] and named "Perspecta Sound." Mention was made under the heading "Control Tones," of the use of control tones of subaudible frequency. In the Fine system there is only one soundtrack (variable-area, photographic) in the standard position, but three loudspeakers behind the screen, fed through separate variable-gain amplifiers. Three control tones, superimposed on the sound recording and separated in reproduction by filters, control the gains of the three amplifiers so that the apparent source can be made to shift across the screen, and the total sound level may be varied as desired to increase the dynamic range. The Perspecta-Sound recording if reproduced on a standard system (not equipped to make any use of the control tones) would, except for a slight reduction in level, be indistinguishable from a standard recording. M-G-M and Paramount have been particularly interested in Perspecta Sound and have equipped numerous theaters with it.[342]

Another sound-placement system was developed by the Dorsett Laboratories of Norman, Okla., and has been installed in a number of theaters in Texas and Oklahoma. It is described in the May 1954 Progress Report[339] as using a standard optical track, but with provision for shifting the sound from the center speaker to either of two screen speakers to right or left, or to peripheral (surround) speakers. This is accomplished by "switching cues in the form of a binary code marked into both sprocket-hole areas," and optically scanned. "Standard single-track optical release prints are cued for use with this system by the Dorsett representatives." (Quotations are from the Progress Report.)

*Sound and Color.* Since in color pictures the silver is removed from the emulsion, special handling of the soundtrack is required. In the Technicolor imbibition process the soundtrack is printed in the usual way, the remainder of the film is then cleared of all silver, and the pictures produced by dye transfer from relief masters.

With the multilayer color films such as Kodachrome, Kodacolor, Anscocolor and a number of more recent types it would be possible to expose the track with white light so that all three dyes contributed to the density, or with colored light so that the sound image would be principally in the top layer, and reproduce with a filter of the complementary color. The principal problem with this procedure is that existing projectors are nearly all equipped with caesium photocells whose sensitivity extends well into the infrared, in which range all of the dyes in use are transparent.[343] Substitution of phototubes of other types would mean an objectionable loss of sensitivity. In May 1946, A. M. Glover of RCA reported the development of a blue-sensitive phototube which could replace the caesium tubes in projectors without loss of output.[344,345] However, by this time the makers of color film had begun the use of edge-development processes that form a track of silver or of a metallic salt (opaque to infrared) not removed by the bleach which was part of the picture processing.[346] In one system the silver is in the top layer only, and the dyes in the other two layers contribute to the opacity. The metallic track became general in the handling of sound on color films.[347–350]

*Sound on 16mm Film.* I have confined my story to developments in the 35mm field in the belief that the general principles and practices which solved problems or led to improvements in one case were applicable in the other. It is probably a gross injustice to pass over the valuable work of engineers whose efforts were devoted to 16mm sound, but it seems to be a necessity.

From the start, the recording of sound at 36 instead of 90 ft/min. presented great difficulties. Only the fact that standards were much less exacting made the project practicable. But with each advance in the resolution of high frequencies in 35mm recording, the corresponding principles were applied to 16mm. One factor at least was in the favor of the low film speed, namely the providing of adequate exposure. By the time of the outbreak of World War II sound on 16mm film had improved to the point which made it acceptable for a great number of military applications.[351]

Recording sound on black-and-white reversal film was not too satisfactory, but years later when color films came into wide use, it again became necessary to put the sound on what was essentially a reversal type of film. Particularly successful for this purpose is recording on the individual prints or electrical printing. (See the section with that heading, and the December 1950 paper by J. G. Frayne.[323])

Black-and-white prints, with original sound recorded either on 16 or 35mm films, formed the great bulk of the product before and during the war. Fortunately, fine-grained emulsions could be used. Cost considerations dictated for the most part the use of 16mm negatives and contact prints, and unhappily nearly all of the printers were of the sprocket type. One laboratory adopted 1 : 1 optical printing as its standard.* Much study was given to the possibilities of recording direct positives. Still more development work was devoted to direct optical reduction from 35mm negatives, and this certainly helped resolution and high-frequency response,[339] but in the case of area tracks, neutralization of image spread in the positive by spread in the negative was not easily achieved.[276] The same factor made difficulty in the recording of direct positives, which had had advocates since early in the era of sound pictures. Since 35mm negatives for optical reduction, or 35mm re-recording positives to be used for making 16mm negatives give best results if recorded with different degrees and kinds of high-frequency pre-equalization, the organizations producing these masters have worked together to establish standards of recommended characteristics.[352]

Adding sound to 16mm films by use of a stripe of magnetic material promises to become of great popular and commercial importance.[353]

*Drive-in Theaters.*[354] The drive-in theater was first proposed and advocated by R. M. Hollingshead, a businessman of Camden, N.J., not affiliated with motion-picture or electronic interests. The first such theater was built near Camden in 1933. In the earlier experiments with the system effort was made

* Precision Film Laboratories, New York, operated by J. A. Maurer.[340]

to put out enough sound power from a screen speaker to enable patrons to hear satisfactorily in their cars. This presented great technical difficulties, and also would have restricted theaters to locations where the noise would not be too objectionable. Several arrangements were tried, one with loudspeakers distributed over the field so that each speaker provided sound for two cars side by side. This was a great improvement from the noise standpoint, and the theaters previously equipped with screen speakers were converted. However, these "out-car" speaker arrangements still left something to be desired on the score of general noise. The "in-car" speaker, introduced by RCA in 1941, provided sound which was much more satisfactory to patrons and practically eliminated the neighborhood-noise problem. In the design of "in-car" speakers, the qualities of ruggedness, conveniently small size without too much sacrifice of sound quality, and immunity to damage by weather were design objectives.[355] The amplifier and audio-power distribution system had to be such that the individual levels would not be too much affected by the number of speakers in use. During the 1930's a number of drive-in theaters were built in New England, in the South, and (through the efforts of Philip Smith) in Indianapolis, Cleveland, Detroit, Milwaukee, St. Louis, Kansas City and Pittsburgh. Building activities were practically at a standstill during the war, but after its close the number increased rapidly. Underhill[356] gives the number of drive-in theaters at the end of the war as about 60 and four years later as 1000. He attributed the rapid growth just after the war in part to the greatly increased number of cars on the road, especially after the end of gasoline rationing, and in part to the shortage of building materials which made the construction of indoor theaters relatively difficult and expensive. The May 1954 Progress Report puts the number of drive-in theaters at the end of 1953 at 4000, and estimated that six months later there would be 4500.

The most serious problem of the drive-in theater is the provision of sufficient light for the large screen, a consideration, however, which lies outside the scope of this paper.

**Magnetic Recording**

The principle of magnetic recording was demonstrated in 1900 by Valdemar Poulsen, who called his device the "Telegraphone."[27,357] About 1917 the American Telegraphone Co. marketed a dictation machine under that name which performed well by existing standards but was complicated and could not compete commercially with cylinder machines. Recording was on 0.010-in. "piano" wire, contacted from opposite sides by a pair of offset steel pole-pieces. Erasure was by a saturating d-c field, and a d-c bias was combined with the recording-voice current in sufficient magnitude to maintain all the recorded magnetization of the reversed polarity.

An alternating magnetic field has for years been the accepted means of demagnetizing magnetic materials, and it seemed a paradox that a superimposed alternating current would assist in, rather than obliterate, recording. However, it was found in 1921 by W. L. Carlson and G. W. Carpenter, then working on a government project of recording telegraph signals, that a bias current of supersonic frequency could be very advantageous in magnetic recording of audio-frequency signals.[358]

The development of magnetic recording was carried on by the Bell Telephone Laboratories during the 1930's. A thin steel ribbon about $\frac{1}{8}$ in. wide was found better than wire, and alloys of superior magnetic properties were developed. Direct current erase and bias were used in the equipment.

The developments and publications of Marvin Camras[359,360] of Armour Research Foundation aroused widespread interest in magnetic recording and the results obtainable with high-frequency bias. The essential difference between a recording made with d-c bias, and one made with high-frequency bias is that with the latter (1) modulation is through zero, with resultant increase in maximum recordable amplitude, and (2) there is no remanent magnetism when the modulation falls to zero. The second feature is the condition for low background noise. The comparison is analogous to that between a Class B push-pull photographic record, and a unilateral recording without ground-noise reduction.

There was much developmental activity in wire recording just before and during the war, with numerous applications for the armed services. The extreme compactness of recordings stored as magnetized wire plus the ruggedness of the system with respect to mechanical injury made it of especial value for military uses. Better wires were developed, 4- to 5-mil diameter sizes being widely used. The Brush Development Co. developed a compound wire in which an alloy of superior permanent magnetic properties was plated on a brass core.[357] The National Standard Co. of Niles, Mich., developed a successful stainless-steel recording wire.

S. J. Begun[357] quotes an article in *Machinery* of January 1917 about the Telegraphone in which mention is made of a stripe of powdered iron to be painted on a motion-picture film to provide synchronous sound. It was more than 30 years later before use was made of this principle — one of the many examples of development in which the basic concept is only a small part of the invention, and the real contribution to progress the result of laborious experimentation and wise application of refinements and better techniques. Not until a sound quality was attained in magnetic recording surpassing that of any other known system did it become of great concern to motion pictures.

Development of magnetic coatings on paper or other base materials was undertaken by the AEG in Germany about 1928, but up to the outbreak of war nothing of outstanding quality had appeared. At the close of the war the American occupying forces brought back samples of a new German magnetic tape and equipment. The magnetic material was a finely divided iron oxide, mixed with a binder and coated on a thin cellulose base (total thickness about 0.002 in.). In the recording magnet a supersonic bias current was superimposed on the audio current. Magnetization was longitudinal, produced by C-shaped magnets of high-permeability alloy, with very short gaps where they contact the tape. Reproducing magnets were similar. In cleanness of reproduction, low ground noise and volume range the German system set a new high standard.

A period of intensive development followed the demonstrations. Some time was required before American firms could match the quality of the German tape, especially with respect to freedom from noise. Numerous papers were published describing basic properties of magnetic materials,[361,362] analysing the action of the supersonic bias,[363,364] and reporting tests on various tapes to determine optimum bias, relation of distortion to recorded amplitude, and amount of residual noise.[365] Among the first in this country to produce acceptable tapes was the Minnesota Mining & Mfg. Co.[361] Experimenters tried the magnetic black oxide ($Fe_3O_4$) in powder form and found it capable of producing higher output levels but noisier than the red oxide used in the German tapes. The red oxide ($Fe_2O_3$) in a certain crystal form ("gamma phase") is magnetic. Grinding to a particle size of about 1 $\mu$ or less was found essential, and prolonged mixing. Many tape-recorder-reproducer equipments were developed, both for amateur and professional use, the latter principally for broadcast stations.

*Advantages of the Magnetic System.* The compactness and portability of the magnetic-tape equipment, its freedom from dependence on laboratories, the immediate playback, the small storage space required, the relatively small cost of recording stock, plus the ability to reuse tape when the recorded sound on it is no longer wanted, the ability to work in daylight, and finally the excellent sound quality and dynamic range, combined to make the magnetic system a

great advance from both the economic and performance standpoints.

*Uses in the Motion-Picture Industry of Nonsynchronous Recording.* The prompt interest of motion-picture producers in magnetic recording was shown in two lines of activity. The Basic Sound Committee of the Motion Picture Research Council held meetings in *1946* to which prospective suppliers of magnetic-recording equipment and record materials were invited.[366] The purpose was to formulate the requirements of the motion-picture industry in order that developments might be better directed toward meeting these requirements. The other activity was making experimental use of the nonsynchronous thin-tape recording equipment which was the first to be developed.[300] While the most important use which might be made of the magnetic system would be for the original synchronous recordings, there are numerous operations for which the lack of exact synchronism of magnetic tape would not be too serious an obstacle, such as for immediate playback after rehearsals, for training singers and actors, and for recording of music and sound effects which do not have to synchronize exactly with the picture. In musical numbers the picture is often secondary to the sound, and in many cases the practice had been followed of recording the sound first, without picture, and subsequently fitting the picture to the music. For this, initial recording on tape was applicable, the sound being re-recorded to film while musicians or vocalists performed synchronously for the camera.

*Papers on Progress in Magnetic Sound.* At the October 1946 convention of this Society Marvin Camras described and demonstrated synchronous magnetic sound, using 35mm film coated at Armour Research Foundation. However, the coated film was not offered commercially. At the same meeting H. A. Howell[302] of Indiana Steel Products Co. gave data on several magnetic materials and described a coated-paper tape which could be perforated if desired. While paper offered certain advantages which commended its use at the time, it has not been possible with coatings on paper to attain the quality and low noise that are realized with bases of clear plastic.

In February 1947 the Du Pont Co. furnished RCA with samples of coated 35mm film base. A conversion kit was developed so that a standard RCA photographic recorder (PR-23) could record and reproduce magnetically. The November 1948 issue of the *Journal* contains a description of the kit by Masterson,[367] measurements of the properties of the Du Pont film reported by O'Dea,[368] and bias studies by Dimmick and Johnson[345] of ¼-in. thin tapes made by Du Pont and by Minnesota Mining & Mfg. Co. as compared with one of the German tapes. The commercial version of the conversion kit was described by Gunby[369] at the October 1948 convention. In the June 1949 *Journal* Mueller and Groves[200] describe experiences at Warner Bros. Studios with various uses of nonsynchronous magnetic recording, and such experience as had been had up to that time with synchronous magnetic recording. The practice of re-recording from magnetic to direct-positive photographic tracks is mentioned. This has sometimes been called "electrical printing," and soon became the prevalent method of providing a sound film to be edited and then re-recorded to the final release negative. The January 1952 paper by Carey and Moran[223] states that the practice of re-recording from a magnetic original to a 200-mil push-pull variable-area direct positive for editing had been followed by Universal International Pictures since January 1951.

The Progress Report of May 1951 shows RCA synchronous magnetic recording equipment, designed to make one, two, or three tracks on the film.* This was being used by Columbia, the sound being re-recorded to direct positives for editing. The same report tells of Westrex portable synchronous magnetic-recording equipment, suited (optionally) to 35mm, 17½mm or 16mm film, describing this equipment as in wide use in this country and abroad. Triple-track Westrex equipment is described by Davis, Frayne and Templin[371] in the February 1952 *Journal*.

Portable magnetic-recording equipment (the complete channel weighing less than 100 lb) using 17½mm film was described by Ryder[372] at the April 1950 convention. The May 1951 Progress Report states that since April 1, 1950, all Paramount production recording had been done on this equipment.

The Progress Report[373] of May 1952 states that by the end of 1951 approximately 75% of the original production recording, music scoring and dubbing in Hollywood was being done on magnetic-recording equipment.

*Editing.* While it is entirely possible to edit magnetic recordings with the help of quick-stop reproducers, sound-film editors have come to depend in part on the visibility of modulation in a photographic track. This is probably one of the chief reasons for the retention of photographic-sound records for this intermediate function. Push-pull recording is usual, and in order to add as little ground noise as possible, preferably wide-track. The use of direct positives saves time as well as printing losses. When the editing is completed, the negative for release printing is made by another re-recording operation.

To provide the visual advantages of the photographic track for purposes of editing while retaining the quality advantages of the magnetic system, an arrangement has been tried which registered by an ink line on the magnetic film the amplitude of the modulation being recorded.[370] Another expedient, described by Frayne and Livadary,[374] is to make simultaneous tracks on the film to be edited, one magnetic and the other photographic variable-area, the magnetic to be used for the re-recording.

A system in which both pictures and sound can be backed up at any time without loss of synchronism is described by George Lewin[377] of the Signal Corps Pictorial Center. This makes it possible for a narrator to correct or change his speech, erasing portions of the previous record as he substitutes the new.

*Synchronous Thin Tape.* While use of perforated film afforded the necessary synchronism, the thin tape has the important advantages of reduced size and weight of equipment, smaller space required for storage, lower cost, and better contact between magnet and record surface because of its greater flexibility. A number of systems have, therefore, been developed to drive tape in strict synchronism. These have for the most part used the principle of recording a tone on the tape in addition to the audio modulation and of controlling the speed of the driving system so as to hold within limits the phase relation between the reproduced tone and a reference frequency, usually the 60-cycle power which drives the camera. The recorded tone may be 60 cycles[375] (excluded from the audio by a high pass filter) or a tone slightly above the audio range for example 14,[376] 15[377] or 18[378] kc, and modulated at the 60-cycle rate.

An optical tone on the tape, as by stripes on the back of the tape would have certain advantages (one of which is that full voltage can be developed from standstill), but this has to the best of my information not been made commercial.

Experiments have indicated that with a suitably designed mechanical system, perforations and sprockets are not out of the question, even with tape as small as 0.002 in. thick by ¼ in. wide.[379]

*Striping.* While magnetic sound has been thus far used mainly in the preliminary operations of making sound pictures, and release prints are still

* The use of three tracks on a 35mm film was begun by Columbia in November 1950. In single-channel recording the three tracks could be used in succession, or in recordings calling for combined voice, orchestra and sound-effects these could be independently and simultaneously recorded and later mixed for desired balance.

optical, there are some exceptions, for example the films for the CinemaScope system, on which the sound is all-magnetic. This calls for applying stripes of magnetic coating on the photographic film which carries the picture. There are also numerous applications, especially with 16mm films, for which it is desirable to add sound to an existing picture film, and other uses for which the stripe is applied to the unexposed film.

The application of the magnetic material in stripes of closely controlled width, position and thickness is no simple problem. The April 1953 *Journal*, Part II, carries a series of papers dealing with problems of magnetic recording. Striping is discussed by representatives of Reeves Soundcraft Corp.,[350] Minnesota Mining and Mfg. Co.,[351] Eastman Kodak Co.[352] and Bell and Howell.[353] The Minnesota Mining and Mfg. Co. developed a method of application of a stripe by transfer from a temporary supporting tape. Only heat (no solvent or wet cement) is required for the transfer. The Reeves engineers also have papers on the preparation of the magnetic material,[354] and the study of the minute surface irregularities which tend to lift the tape from the magnet causing sound "drop-outs."[355] In spite of the utmost effort to prevent the formation of such high spots they are not entirely eliminated, and polishing operations are helpful. Other papers in the group deal with wear on magnets,[356] measurements of magnetic induction,[357] and standardization.[358]

The May 1954 Progress Report mentions new high-output magnetic-oxide coatings introduced in 1953 and 1954 by Minnesota Mining and Mfg. Co., greatly increased use of striping, new machines for applying the stripes, and several designs of theater soundheads (to be mounted above the projector head) for reproducing multiple-track magnetic sound.

A Sound Committee Report by J. K. Hilliard in the June 1953 *Journal* tells of arrival at agreement for a standard of track positions for triple 200-mil magnetic tracks on 35mm film, of projects for standardizing theater magnetic-reproducing characteristics, and plans for making available various magnetic test films, corresponding to the long-used photographic test films.

Theater reproducing systems for magnetic tracks are designed to be mounted on the tops of projectors, and do not interfere with the optical reproduction.

*New Safety-Film Base.*[359,360] For years the motion-picture industry struggled to minimize the fire hazard of nitrate film. Safety-film base had early been developed and used for certain purposes for 35mm film, and was mandatory for amateur equipment (16mm), but the stability and mechanical properties of the safety base were so inferior to the nitrate base that it was not a satisfactory substitute.

The film companies worked long and diligently on the problem of improving film-base stock. In 1937 the Eastman Co. adopted an improved safety base,[360] and in 1948 announced a new safety base which combined the needed properties to replace the long-used nitrate base, being superior to the nitrate in heat resistance and low shrinkage. It is described by Fordyce[361]. With these virtues the new film has rapidly supplanted nitrate.

The improvement in sound quality due to reduced shrinkage may not be noticeable to the average listener, but it must inevitably mean better performance especially in the action of contact printers. The importance of this new base can hardly be exaggerated.

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## APPENDIX

### Development of High Vacuum Amplifier Tubes from the Audion

A brief account of the improvement of the audion by Dr. Arnold of the Western Electric Co., and of the subsequent patent interference and litigation, appeared in *Jour. SMPE, 17:* 658–663, Oct. 1931. In view of the vital part played by the electronic triode, it seems appropriate to tell something more about the parallel developments at the General Electric Co. The results, in terms of practical, high-vacuum amplifier tubes, were attained independently and at very nearly the same time at the two laboratories. The Telephone Co. had immediate use for audio amplifiers and promptly put them to use on a large scale, whereas, at the General Electric Co., the work was much more nearly a pure research.

Study at the Research Laboratory of the General Electric Co. of the relation of "Edison Effect" current to residual gas was an outgrowth of incandescent lamp development. Because of serious effects in some cases of the minutest traces of impurities or of certain gases or vapors, the techniques of producing high vacua had been developed to a high degree. In the early days of the Fleming valve and the de Forest audion the opinion was widely held that these depended for their conducting properties on the presence of some gas. Experiments in 1907 by Prof. Soddy[205] of the University of Glasgow lent support to the belief that the space current would become zero if a true vacuum were obtained. On the other hand, the English scientists J. J. Thompson (who first proved that there was such a thing as an electron) and O. W. Richardson believed that high temperature would cause a conducting body to throw off electrons into the adjacent space, without dependence on the potent effects (in releasing electrons) of impacts on the cathode surface by positive gas ions. It was the question which of these theories was right that enlisted the interest of Dr. Irving Langmuir. By using the known techniques for driving occluded gases from glass and metal surfaces, the Gaede diffusion pump, and adding a liquid-air cooled trap in the exhaust line, Dr. Langmuir exhausted his experimental tubes to about the highest possible vacuum. He showed that (with adequate temperature of the tungsten cathode) a pure electron space current flowed, and that this current followed the theoretically predicted 1.5 power relationship to the anode potential.[207]

With high enough anode voltage to carry over all the electrons emitted by the cathode ("saturation current") Langmuir was able to verify O. W. Richardson's prediction ("The electrical conductivity imparted to a vacuum by hot conductors," *Phil. Trans. 201:* 497, 1903) that the rate at which electrons are "boiled" out of the cathode bears a similar relation to temperature that vapor pressure does in the case of an evaporating substance. The presence of small quantities of ordinary gases (other than the "noble" gases) was found to "poison" the tungsten surface and greatly reduce emission, but this effect disappeared at high enough temperatures.[207]

These studies were begun in August 1912, and continued through that year and the following. Three electrode tubes exhausted to high vacuum were found to be free from the voltage limitations and erratic behavior of the previous audions.[208] Another important outcome of the development of the pure electron discharge was the Coolidge X-ray tube (hot-cathode, high-vacuum type) in which the electron velocities at the anode (and thereby the frequency or penetrating power of the X-rays) could be accurately and reliably controlled, and carried to much higher values than had been possible in the previous tubes where gas ionization had limited the effective anode voltage. The use of chemical "getters" for improving the vacuum in sealed-off tubes was also much advanced by work at this time at General Electric. In October 1913, a patent application was filed for Langmuir on "Electrical Discharge Apparatus" (triode) in which conduction is entirely by electrons, the effects of gas ions being negligible.

The audions which de Forest supplied for radio reception broke into a glow discharge if anode potentials of more than 20 to 40 were applied, and all control by the grid then vanished. The very limited output with low-voltage operation was not serious for radio detectors, but made the

tubes of little or no use as amplifiers. During the years 1909–1912 de Forest was employed by the Federal Telegraph Co. of California. The company wanted amplifier tubes and de Forest ordered some made with better vacuum, calling in some cases for re-exhaust, so that by August 1912, a tube was being used at 54 v and by November, one at 67½ v. This was held in some of the later court actions to be a clear indication of the direction from which improvement in the audion could be expected and thus, so far as invention or discovery goes, an anticipation of possible patent claims by others, directed to improving the audion by employing higher vacuum.

At the time that the work just described was going on, the Telephone Co. was making plans to establish transcontinental telephone communications in time for the opening of the San Francisco Panama-Pacific Exposition in 1915. There had been a long-felt need for a voice-current amplifier, much effort had been expended on the project, and devices based on various principles tried.

For the 3000-mile transmission the possession of amplifiers would be imperative and they must have low distortion to permit cascading. According to the accounts by Lovette and Watkins,[48] and by Wm. R. Ballard,[392] a visit by de Forest in October 1930 served to direct attention to the possibilities of the audion, other devices of promise having till then claimed the research efforts. De Forest gave demonstrations and left a sample for tests and study. The demonstrations were repeated next day for the benefit of research engineer Dr. H. D. Arnold, who was quick to recognize the potentialities of the audion, the requirement for high vacuum and the role of space charge in limiting and controlling electron current. He expressed entire confidence that an amplifying tube which would meet the requirements could be developed from the audion, and he was assigned the task. Progress was rapid, and tubes with much higher vacuum were quickly available, but vacuum of the desired value was not achieved until a Gaede molecular pump, which was ordered from Germany, arrived. Long-lived cathodes were of great importance for telephone applications, and cathodes of the Wehneldt oxide-coated type were developed to replace de Forest's tungsten cathodes.

More details about the developments at the Western Electric Co. will be found in the references already cited.[48,393] Doubting the patentability of the improvement brought about by higher vacuum, Arnold and his attorneys did not file any application until they learned that an application based on a similar development had been filed by the General Electric Co. The prolonged interference which followed is summarized in the footnote on page 657 of the October 1931 *Journal*, "After various conflicting opinions by successive tribunals, U.S. Pat. No. 1,558,436 was issued to Langmuir in 1925."

In 1926 the General Electric Co. brought suit for infringement against the de Forest Radio Corp. Again there were decisions, appeals, and reversals, ending with the ruling of the Supreme Court, May 25, 1931, that the patent did not involve invention.

Some light on the questions at issue may be found in opinions written by the successive courts.

Court of Appeals of the District of Columbia (339 *Official Gazette* 56). Patent issued pursuant to finding of this court.

Federal District Court for Delaware before which the General Electric vs. de Forest suit was tried (*Federal Reporter, Vol. 23, 2nd Series*, p. 698).

U.S. Circuit Court of Appeals for the Third District (44 *Federal Reporter 2nd Series*, p. 931, and *U. S. Pat. Quarterly*, Oct.–Dec. 1930, p. 67). Majority opinion for plaintiffs and dissenting minority opinion.

U.S. Supreme Court (283 U.S. 664, *Baldwin Vol. XI* 664).

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## Errata

In the second installment of this paper, published in the July *Journal*, the titles appearing under Figs. 8 and 9 should be interchanged; in the title to Fig. 14, "variation" should read "various"; and the title to Fig. 16 should read: "Horizontal cross section showing sound passages of folded low-frequency horn."

# Revised Standard for Volume Measurements of Electrical Speech and Program Waves

By ROBERT B. MONROE

**A revised standard covering American standard practice for volume measurements of electrical speech and program waves was recently issued and is published at the end of this introductory article. This paper describes briefly the needs leading to the new standard and points out the major differences between the new and the preceding standard.**

A REVISED standard covering American standard practice for volume measurements of electrical speech and program waves was recently issued by the American Standards Association.[1] This new standard supersedes the original standard covering this subject[2] that had been in effect for twelve years. It is the purpose of this paper to review briefly the events that made the new standard necessary and to point out the major differences between the new standard and the original.

### Background

Today, one of the simplest measurements in audio engineering is the measurement of audio volume. All that is necessary is a standard volume indicator that is calibrated, used and read in the prescribed manner.

The measurement of audio volume was not always this simple. As a matter of fact, it was only a little more than fifteen years ago that the increasing difficulty in correlating volume measurements caused the broadcasting networks and telephone companies to get together for the express purpose of standardizing methods of measuring audio volume. Out of these meetings came agreement and standardization upon (a) an entirely new volume indicator having carefully prescribed dynamic and electrical characteristics, (b) a standard reference level for calibration of the new volume indicator and (c) a new terminology wherein readings on the new volume indicator were expressed in "vu". These developments were the basis of the now outdated ASA Standard C16.5-1942.

The volume indicator that was standardized by ASA C16.5-1942 was basically a 600-ohm device, that is, the instrument was calibrated to read correctly when connected across 600-ohm circuits. When used across circuits of other impedances, a correction was necessary. The choice of 600 ohms as the standard impedance was influenced by the fact that the majority of the plants at that time used 600-ohm equipment.

However, in 1949 the Radio-Electronics-Television Manufacturers Association (RETMA) issued a standard covering audio facilities for radio broadcasting systems.[3] In this standard, the input and output impedance of broadcasting audio amplifiers were standardized at 600/150 ohms. In the same standard, broadcasting microphones were standardized at 150 ohms.

From the viewpoint of broadcast audio system design, this RETMA standard was very desirable inasmuch as it made it possible, through use of the 150-ohm alternate impedance, to design an entire broadcasting plant, from microphones to outgoing lines, using nothing but 150-ohm circuits. The use of 150- rather than 600-ohm circuits makes it considerably easier to meet the FCC response-frequency performance requirements for FM and TV sound broadcasting inasmuch as losses at the high audio frequencies are greatly reduced. Furthermore, modern broadcasting plants owe a great deal of their reliability of service to the use of jackfields and patchcords which permit any defective component to be replaced during the progress of a program. This practice makes it desirable that all circuits in the system have identical impedance characteristics so that patching can be accomplished without introducing any impedance mismatches with resultant degradation of performance.

For these reasons, a great many broadcasting plants adopted 150 ohms as a standard impedance for all audio equipment and circuits.[4] Doubtless many more will adopt the 150-ohm standard when existing audio equipment is replaced.

One difficulty arose when designing 150-ohm audio systems. The standard volume indicator, when bridged across 150-ohm circuits, is not capable of reading levels lower than +10 vu as contrasted to +4 vu when used across 600-ohm circuits. At the same time, the *standard* audio level used for feeding program material to telephone lines[5] is +8 vu. Therefore the standard volume indicator, when connected across a 150-ohm program circuit carrying standard audio-program level, will not be deflected to the reference point.* It is desirable, therefore, that a 150-ohm volume indicator having at least the same sensitivity as the 600-ohm instrument be made available.

Several acceptable methods of increasing the sensitivity of 150-ohm volume indicators have been suggested. One of these methods involves the use of a more sensitive meter for the volume indicator. Another method, and the one in general use, employs a transformer to step up the voltage delivered to the meter.[6] However, ASA C16.5-1942 specifically covered only volume indicators calibrated for use in 600-ohm circuits and therefore a 150-ohm instrument, or for that matter an instrument for any impedance other than 600 ohms, would not, strictly speaking, be a standard volume indicator.

To clear up this predicament, the RETMA in 1951 requested the Institute of Radio Engineers (the sponsor of ASA C16.5-1942) to expand the standard to permit provision for instruments calibrated for use in circuits other than 600 ohms. This was done, and the new ASA Standard C16.5-1954, "American Standard Practice for Volume Measurements of Electrical Speech and Program Waves," provides for volume indicators calibrated for other impedances. It also has incorporated other changes that are described below.

*This does not necessarily preclude the use of the instrument for reading *standard* transmission levels in 150-ohm circuits. It is often possible to connect it at a point in the circuit where a level higher than +8 vu exists, for example, before the line pad generally used in feeding a telephone line.

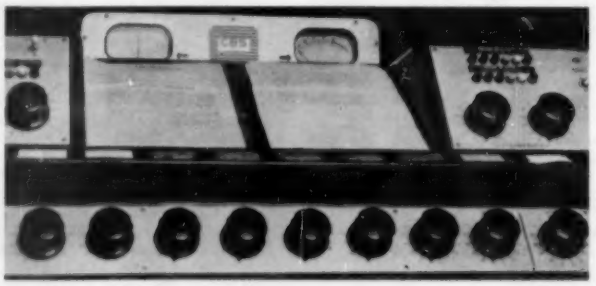

**Fig. 1. Two standard volume indicators are used for monitoring audio program material on the CBS 3E audio console at CBS-Television Color Studio 72 in New York City.**

An invited contribution, submitted on May 9, 1955, by Robert B. Monroe, CBS Television, 485 Madison Ave., New York 22.

### The New Standard

Basically, the new ASA C16.5-1954 Standard is ASA C16.5-1942 revised and brought up to date. In the revision, quite a few editorial changes were made in the original text where it was felt that the intent would be made more explicit. The entire section dealing with definitions was changed to make them conform to the new IRE Standards on Audio Techniques: Definitions of Terms, 1954.[6] Changes were also made to clear up a common misunderstanding regarding the correct method of determining the program level being measured. This operation involves the meter sensitivity, the attenuator setting and the pointer deflection.

As described above, one of the most important changes in the new standard is the rewording that makes it standard practice to calibrate volume indicators at impedances other than 600 ohms. This was accomplished merely by substituting the expression "*R* ohms" wherever "600 ohms" was specified in the original C16.5-1942 text. Although the standard now permits calibration for any circuit impedance, it is stated, in the section on "Good Engineering Practice," that "the preferred circuit impedances (*R* ohms) for calibration of the instrument are 600 and 150 ohms." The same section also specifies that "the nominal input impedance of the device and the impedance for which it is calibrated should be marked on the panel of the volume indicator assembly. This designation may be omitted when the volume indicator is a bridging device calibrated for 600 ohms."

The new standard includes two specifications pertaining to the meter scale card which, although covered in early papers describing the volume indicator,[7] were not included in ASA C16.5-1942. The first of these scale-card specifications states: "The color of the scale card, expressed according to the Munsell system of color identification, should be 2.93Y (9.18/4.61)." The second deals with distracting markings on the meter scale card. It states: "No markings other than those associated with the scale should be visible on the scale plate when the indicating meter is viewed directly from the front."

### Conclusion

The new ASA Standard C16.5-1954, American Standard Practice for Volume Measurements of Electrical Speech and Program Waves, takes cognizance of the widespread use of 150-ohm circuits in broadcasting and other professional audio systems and provides for standard volume indicators to be calibrated for use in these circuits. In addition, the new standard formalizes some of the design details which, although they were a part of the original instrument specifications,[7] were not incorporated in the original ASA Standard.[2]

The new standard was prepared by the IRE Audio Techniques Committee. It was published as an IRE Standard prior to its adoption by the American Standards Association.[8] The industry owes a vote of thanks to C. A. Cady, Chairman of the IRE Audio Techniques Committee, and to the committee members for their exacting and concise work in preparing this new standard. Acknowledgment is also due Howard A. Chinn, CBS Chief Audio-Video Engineer, one of the originators of the standard volume indicator and ASA Standard C16.5-1942, for his enduring interest in this subject and for his counsel in the preparation of this paper.

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# American Standard Practice for Volume Measurements of Electrical Speech and Program Waves

C16.5-1954

### 1. General

These standards apply to the methods of and a device for measuring the dynamic magnitude of complex audio-frequency electrical waves such as occur in speech and music.

The measurement of the complex and nonperiodic waves encountered in electrical communication cannot be expressed in simple fashion in the ordinary electrical terms of current, voltage, and power. The concept of "volume" furnishes a practical method of great utility to the communications engineer for assigning a numerical value to the magnitude of electrical speech and program waves.

Volumes are read by noting the more extreme meter deflections of a device known as a volume indicator. Since the response of the meter of such an instrument to the rapidly varying waves is greatly dependent upon its dynamic characteristics, a standard for volume measurements must, therefore, include a specification of these characteristics.

This standard uses the term "vu" to express volume in terms of vu above or below a specified reference level, defined herein.

### 2. Definitions

The following terms apply specifically to the standard volume indicator and its use.

*2.1 Volume.* The magnitude of a complex audio-frequency wave in an electrical circuit as measured on a standard volume indicator.

*2.2 Standard Volume Indicator.* A device for the indication of volume, and having the characteristics described in Section *3.*

Note—A standard volume indicator consists of at least two parts:

(a) A meter.

(b) An attenuator (adjustable loss) or pad (fixed loss).

*2.3 vu* (pronounced "vee-you" and customarily written with lower case letters). A quantitative expression for volume in an electric circuit.

Note 1—The volume in vu is numerically equal to the number of db which expresses the ratio of the magnitude of the waves to the magnitude of reference volume.

Note 2—The term vu should not be used to express results of measurements of complex waves made with devices having characteristics differing from those of the standard volume indicator.

*2.4 Reference Volume.* The level which gives a reading of 0 vu on a standard volume indicator.


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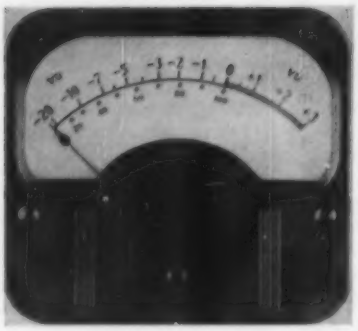

**Figure 1.**

Note 1—The methods of reading and calibration are described in Section 3.

Note 2—The "reading of 0 vu" is the algebraic sum of the meter and attenuator readings on the standard volume indicator.

*2.5 Reference Deflection.* The deflection to the meter-scale point marked 0 vu, 100, or both.

Note 1—This is the deflection at which the meter should be used.

### 3. Standard Volume Indicator

Volume is measured by means of a volume indicator. This device must conform to the following specifications and must be used in the manner described below.

*3.1 Circuit Impedance.* The magnitude of the circuit impedance across which the volume indicator is intended to be connected is designated herein as "$R$" ohms, which is the resistive impedance used for calibration. When so used, the requirements of Sections 4.2 and 4.5 must be met.

Note 1—The impedance presented to the volume indicator by a circuit impedance of "$R$" ohms is nominally $R/2$ ohms; resulting from the parallel combination of the "$R$" ohm source and the "$R$" ohm load.

*3.2 Dynamic Characteristics.* If a sinusoidal voltage between 35 and 10,000 cycles per second, of such amplitude as to give reference deflection under steady-state conditions is suddenly applied, the meter pointer shall reach 99 per cent of reference deflection in 0.3 second, ±10 per cent, and shall then overswing reference deflection by at least 1.0 per cent and not more than 1.5 per cent. The time required for the meter pointer to reach its position of rest on the removal of the sinusoidal voltage shall not be greatly different from the time of response.

*3.3 Response-Versus-Frequency Characteristic.* The response of the volume indicator shall not depart from that at 1,000 cycles per second by more than 0.2 decibel between 35 and 10,000 cycles per second nor more than 0.5 decibel between 25 and 16,000 cycles per second.

*3.4 Response to Complex Waves.* The response to complex waves of such amplitude as to give reference deflection when read, as described in *3.9*, shall be that equivalent to the response with a direct-current meter and a rectifier, the exponent of whose characteristic is $1.2 \pm 0.2$.

*3.5 Reversibility.* The response when measuring unsymmetrical waves must be independent of the poling of the volume indicator. Such a characteristic may be obtained by the use of a direct-current meter in conjunction with a full-wave rectifier.

*3.6 Graduation of Meter Scale.* The point of reference deflection shall be definitely indicated in some suitable manner. The remainder of the scale shall be graduated in vu above and below reference deflection. (See also *4.4.*)

*3.7 Attenuator Marking.* The attenuator shall be marked in vu.

*3.8 Calibration.* A correctly calibrated volume indicator with its attenuator set at 0 vu will give reference deflection when connected to a source of a sinusoidal voltage adjusted to develop 1 milliwatt in a resistance of $R$ ohms, or with the attenuator set at $n$ vu when the calibrating voltage is adjusted to develop a power $n$ decibels above 1 milliwatt.

*3.9 Method of Reading Volume Indicator.* The reading is determined by the greatest deflections occurring in a period of about a minute for program waves, or a shorter period (e.g., 5 to 10 seconds) for message telephone speech waves, excluding not more than one or two occasional deflections of unusual amplitude. The volume indicator is usually connected across the circuit at a point where the impedance is $R$ ohms and the attenuator is adjusted until the deflections, read as described above, just reach the scale point corresponding to reference deflection. The volume in vu is determined by the markings on the attenuator at the setting thus obtained. If for any reason the deflections reach some other scale point than that corresponding to reference deflection, the volume is given by the algebraic addition of the attenuator setting and the actual deflections as read on the meter scale. When volume delivered to an impedance differing from $R$ ohms is to be measured, the volume indicated must be corrected to correspond to this difference. Correction (to be added algebraically) in vu $= 10 \log_{10} R/|Z|$, where $|Z|$ = magnitude of actual impedance.

### 4. Good Engineering Practice

The following items are not fundamental to this standard but are matters of good engineering practice.

*4.1 Impedance.* The preferred circuit impedances ($R$ ohms) for calibration of the instrument are 600 and 150 ohms. The volume indicator is normally used as a bridging instrument and when so used its impedance must be sufficiently high so as not to influence unduly the waves in the circuit with which it is used. It is good practice to make the value of impedance not less than 12.5 $R$ ohms, for use on an $R$-ohm circuit. This corresponds to an insertion loss of approximately 0.4 decibel.

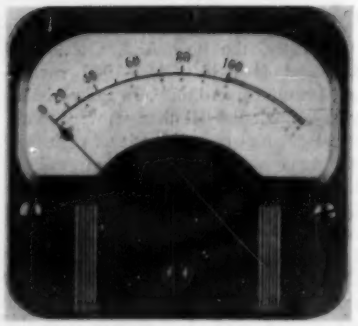

**Figure 2.**

*4.2 Harmonic Distortion.* The root-mean-square value of the harmonic distortion produced when the volume indicator is bridged across a resistive circuit impedance through which a sinusoidal wave between 25 and 8,000 cycles per second is being transmitted should not exceed 0.2 per cent of the fundamental.

*4.3 Ability to Withstand Overload.* The instrument should withstand without injury or effect on calibration, a momentary overload of ten times the voltage corresponding to reference deflection, and a continuous overload of five times that voltage, because of the great variation in amplitude which this indicator may encounter.

*4.4 Scale.* The point of reference deflection should be located within a sector between $\frac{3}{8}$ and $\frac{3}{4}$ of full scale. In addition to the vu scale, a 0-to-100 scale proportioned to voltage should be provided. Samples of the two types of scales in general use are shown in Figs. 1 and 2. The color of the scale card, expressed according to the Munsell system of color identification, should be 2.93Y (9.18/4.61). No markings other than those associated with the scale should be visible on the scale plate when the indicating meter is viewed directly from the front.

*4.5 Marking.* The nominal input impedance of the device and the impedance for which it is calibrated should be marked on the panel of the volume indicator assembly. This designation may be omitted when the volume indicator is a bridging device calibrated for 600 ohms. The marking of the meter scale does not uniquely determine the calibration. For example, the meter sensitivity might be such that 0 vu on the meter scale corresponds to a volume of +4 vu. In this case, the zero-loss position of the attenuator would be marked +4 vu.

# Simultaneous High-Speed Framing and Streak Recording in 16mm

By GEORGE E. HAYS

**A side optical system was added to a 16mm Fastax camera to enable correlation of data with the event photographs or to allow the camera to be used for streak recording. The side optical system was installed without permanent camera alterations through a separate camera door. The image is reflected up to the film plane five frames ahead of the event frame.**

During a recent investigation of combustion processes in a small rocket, an attempt was made to photograph the fuel-injection cycle. Other data were recorded by a multichannel galvanometer oscillograph or a two-channel oscilloscope. To instrument completely for analysis, it was necessary to correlate these data with the event photographs. Several methods were available,[1,2] but these methods limited the frequency response of the system. Also considered was a coded pulsed timing light that would appear on the film as well as on the oscillographic recording.

These methods were all discarded in favor of one that was devised to place the needed data on the film simultaneously with the event frame by using a side lens system. This method can be used on any camera such as the Eastman High Speed or intermittent-type cameras. Two Fastax cameras were available for modification, an 8mm and a 16mm. It was thought that, if possible, the planned modification should not involve any changes in the basic camera and should be interchangeable between the two cameras without any permanent alterations to either. It was desirable that during the modification period both cameras could be used in their normal function. These requirements were satisfied by building a replacement camera door assembly, which fitted either camera.

Presented on April 21, 1955, at the Society's Convention at Chicago by George E. Hays, Power Plant Research Group, The Boeing Airplane Co., Seattle 14, Wash.
(This paper was received on March 16, 1955.)

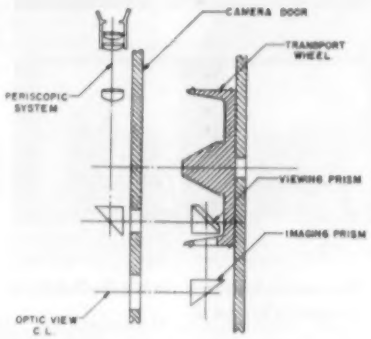


**Fig. 1. Fastax side lens system.**

The side lens system consists of an imaging lens, lens and prism mount and prism (Fig. 1). The imaging lens used is the standard Fastax lens to allow it to be interchanged with the regular lens system. The lens mount is recessed into the camera door with the prism attached to change the optical line of sight. This lens system then images on the film as the film is pulled tangentially off the transport wheel. The location of the side lens system necessitated relocating the timing lamps and housing as shown in the photograph of the camera interior (Fig. 2).

Originally the system was designed to focus the side lens by using the distance-adjusting lens ring and to position the object in the image plane by measurement. A simple but basic fact was overlooked, that of recognizing the field on the final film. After taking a few high-speed streak photographs of shock waves, analysis was attempted; however, little could be done since no information existed concerning the physical nature of the field and its position on the film. A periscopic system was then designed and installed in the side lens camera door to focus and aim the side lens system. By properly positioning the images on the film the two images are side by side, or overlayed if desirable, separated, however, by 1.5 in. or five frames. If necessary a printing technique can be used that will displace either side-by-side image in direct correspondence to each other, but this is usually not necessary for analysis and only slightly improves the sense of the projected film if the film is projected at 24 frames/sec.

The Fastax with this modification can be used, without alterations, as a streak camera. This type of camera requires a masked field (masked in either the image or object plane) in the form of a slit perpendicular to the direction of film travel and a lens to image this selective field on the constantly moving film. The final image displays motion in the selective slit field vs. time. Streak cameras are usually considered to be essentially recording instruments since they do not, in the final film, display a recognizable image of the field but rather an image composed of lines and curves representing the motion of objects in the field along the slit. The common use of this type of camera is to record the indications of

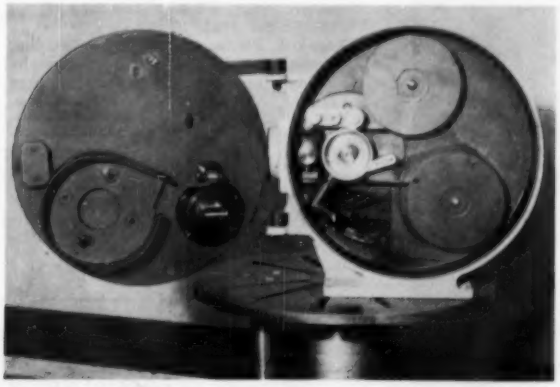

**Fig. 2. Modified Fastax interior.**

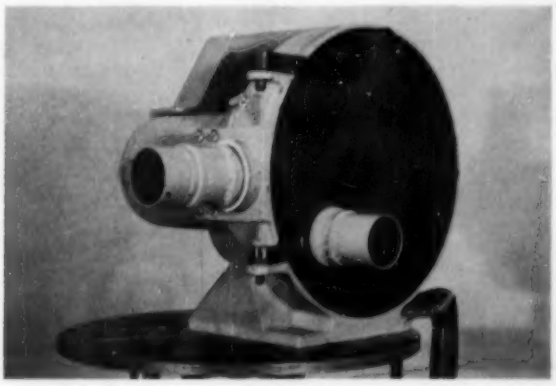

**Fig. 3. Exterior of the side lens system for the 16mm Fastax.**

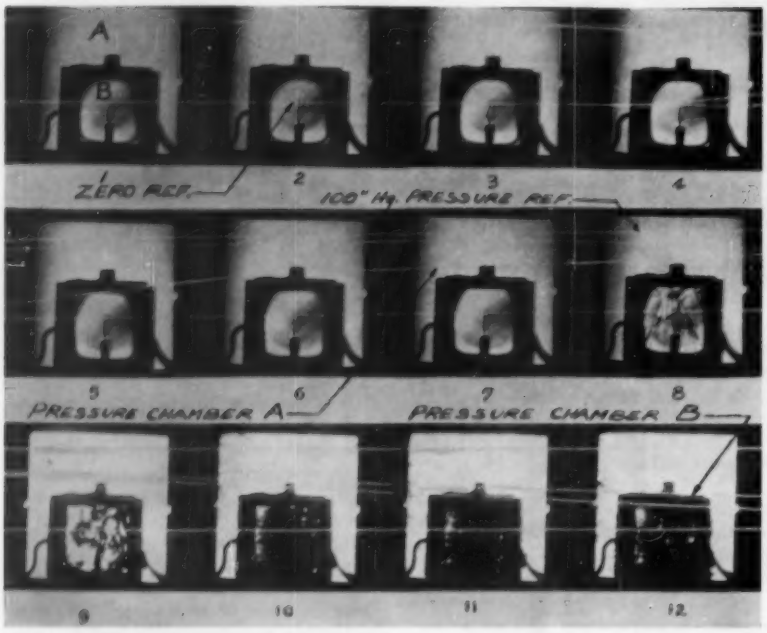


**Fig. 4. Enlarged series of explosion pictures. Oscillographic trace shown in Frame 4 corresponds to the vent recorded in Frame 8.**

cathode-ray tubes, to study periodic motion of objects, and for other cases where only motion of a narrow field is of interest. An example of the third use is the study of the bounce in an operating relay.

The important advantages of streak cameras are the ease of analysis for time-displacement information and the ability of the camera to record a high-frequency cyclic motion. With the Fastax operating at a film speed of 200 ft/sec (2400 in./-sec) and if 0.1 in. is required to display each cycle, then 24,000 cycles/sec can be imaged on the film.

The serious limitation of streak recording is that only the action viewed through a narrow slit is recorded. This limitation can be partially overcome by photographing the entire field with the framing system and the selective slit field with the side optical train.

A framing camera, when used to study an event of a reoccurring or cyclic nature, does not always present a true story of the event, owing to the stroboscopic effect. This effect is caused by the periodic photographing of the successive phases of the cyclic motion under study. If the camera frame speed is out of phase with the frequency (too low or too high), the object appears to move forward or backward. Film analysis of this cycle is badly hampered since without knowledge of the true movement of the object the true frequency is not known. Without other supporting information the motion is confused. This problem can be overcome by selecting the main point of interest and photographing this reduced field through the side lens. Then the actual cyclic parameters of frequency, amplitude and object movement are recorded through the side lens and the entire field through the framing system. By frame selection, using the slit trace as a guide, it is then possible to reconstruct a cycle or a series of cycles by adding any number of separate frames for time magnification.

Presently the modified Fastax camera is being used to correlate data obtained in an explosion test program. The framing lens system records the schlieren image of the explosion while simultaneously pressures, temperatures or other dynamic data as displayed on a two-channel oscilloscope are recorded through the side lens system (Fig. 3). Figure 4 is an enlarged series of frames of an explosion taken by this technique. In this particular case it was necessary to study the mechanism of flame propagation. The two lines are the pressure traces experienced in the chambers and presented to a two-channel oscilloscope. To measure the deflection accurately a small d-c lamp was placed at the static position of the pressure trace on the oscilloscope. A second d-c lamp then was located at the other side of the cathode-ray tube to furnish calibration for any degree of final film enlargement. These d-c lamps are positioned so that they will not interfere with either image, and sometimes they can be replaced with a fiducial marking attachment (obtainable through Wollensak Optical Co.). Since this attachment is optical, any bounce or weave of the film will not shift the X-axis of the fiducial mark used as an image reference point.

An inherent difficulty in this system is in the selection of film. As an example, the problem of choosing film for the explosion testing was complicated since the schlieren event framing required a film such as Super XX or Panatomic X developed in fine-grain developer for medium contrast. The oscillographic recording requires, for high speeds, Linagraph pan or Linagraph ortho processed in a high-emulsion-speed developer for a much longer time than that specified by the film manufacturer. The resulting compromise consisted of reducing the schlieren light to 20% of the amount generally used for proper exposure, and, with Super XX film, prolonging the development time to increase the gamma factor for a readable oscillogram. The final film image is less than ideal but still usable, even with the increased emulsion fog level and grain.

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2. Eugene L. Perrine and Nelson W. Rodelius, "Simultaneous high-speed arc photography and data recording with a 16mm Fastax camera," *Jour. SMPTE*, **57**: 140–144, Aug. 1951.

# New 16mm Television Magnetic/Optical Sound Projector for the Limited Budget

By JOHN S. POWERS
and GEORGE F. KRTOUS

**The increasing use of the vidicon camera as the pickup means in a television film chain has opened the field for a new 16mm magnetic and optical television projector designed for dependable high-quality picture and sound reproduction. This paper describes a projector suitable for film telecasting, using the vidicon camera.**

Film as the program source accounts for much of the air time in the modern television station. In the small station it is usually the major program source. A dependable 16mm projector in the film chain is a must, otherwise air time and the revenue from this time may be lost. Several 16mm projectors have been designed specifically for television use and give very good service, but have the disadvantage of being very expensive to purchase and to maintain.

The small television station which must operate on a limited budget has need for a projector which, in addition to low initial cost, uses service parts and accessories which are readily available and at low cost, primarily because they are used in standard commercially produced film-projection equipment. With this idea in mind, a project was initiated at the Bell & Howell Co. to adapt the Design 614, better known as the JAN (Joint Army Navy) projector, to television use. The Design 614 was chosen because of its ruggedness and excellent picture and sound quality.

Specifications were prepared with the aid of several engineers associated with television stations. The specifications assumed the use of a vidicon camera as a part of the film chain.

The following specifications were thought to describe adequately an ideal television film projector that would be suitable for this application.

(1) Type of film — 16mm
(2) Reel capacity — 2000 ft
(3) Film speed — 24 frames/sec for 60-cycle systems; 25 frames/sec for 50-cycle systems
(4) Picture steadiness — vertical jump less than 0.2% of picture width; horizontal weave less than 0.2% of picture width.
(5) Shutter frequency — 60 or 120 cycles/sec
(6) Light-application time equal to or greater than 30% for a single television field
(7) Flutter and wow less than 0.25%
(8) Frequency response in accord with SMPTE review-room characteristics
(9) No displacement of aperture while framing
(10) Readily accessible exciter lamp and projector lamp
(11) Magnetic and optical reproduce facilities
(12) Long life on all parts of the projector
(13) Synchronous motor drive
(14) Good signal-to-noise ratio
(15) Low distortion

The Design 614 JAN projector (Fig. 1) was considered for this application because most of the features required of a television projector were already inherent in the design. To fulfill the remaining requirements the shutter system, drive motor and soundhead had to be replaced with new parts that would suit the purpose. The projector mechanism lends itself to modifications because it is built up from basic assemblies which can easily be changed, or replaced, with special components or assemblies designed for a particular application. The intermittent movement has sufficient speed so that a 120-cycle shutter could be installed, and yet meet the requirement that the light-application time be greater than 30% of that for a single television field. This requirement is necessary to eliminate the need for synchronization of film pulldown with the television sync-generator field rate.

The projector mechanism is well known in the industry, and is a standard in the Armed Forces. It has many features which are desirable for long life, particularly in regard to the film-moving mechanism. The working tooth of the shuttle, for example, is made of carboloy, a very hard, wear-resisting material. The side guides of the picture aperture are provided with inserts made of sapphire, and film shoes are made of hardened stainless steel. Other details of this machine have been described in past papers, some of which have been published in this *Journal*.

The basic projector also has a change-over system which can be either manually or electrically actuated; and, if desired, an elapsed-time hour counter can be installed to record the number of hours the equipment has been used.

In the standard projector the shutter can be either 48 or 72 frequency, but this shutter rate is not compatible with the television scanning. The shutter used in this unit is 120 frequency; that is, each frame of the film is projected five times.

A graph (Fig. 2) illustrates the rela-

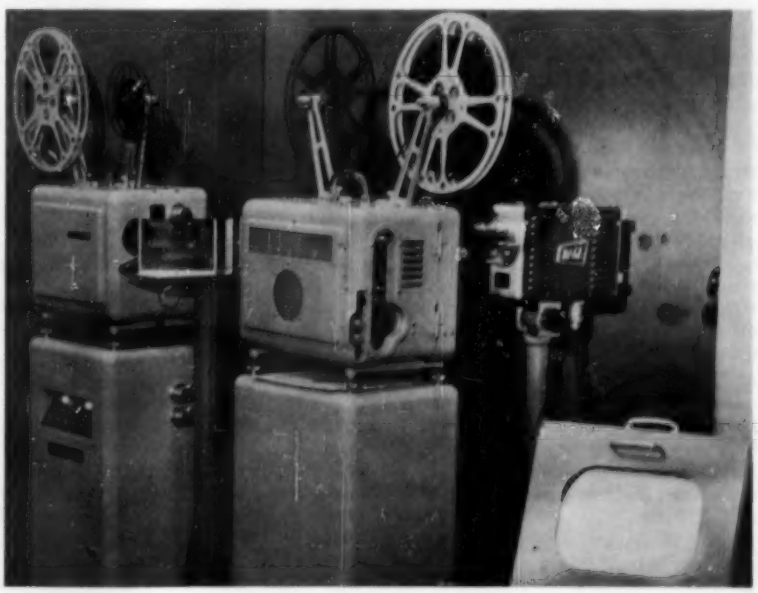

**Fig. 1. The Design 614 JAN Projector.**

Presented by title on April 20, 1955, at the Society's Convention at Chicago by John S. Powers and George F. Krtous, Bell & Howell Co., 7185 McCormick Rd., Chicago 45.
(This paper was received on April 29, 1955.)

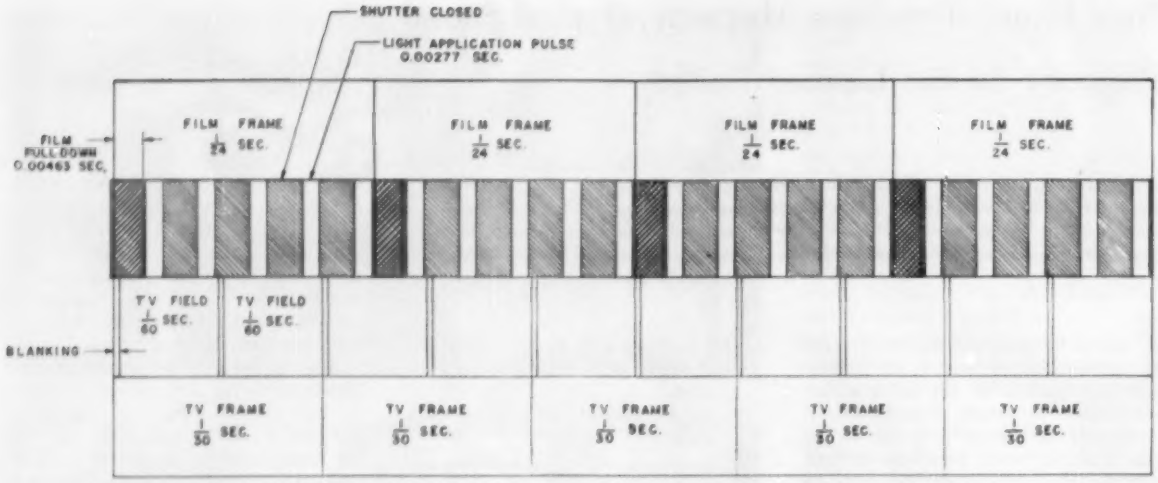


**Fig. 2. Television projector time cycle.**

tionship between the television field and frame rate as against the motion-picture film frame rate. The five light pulses in each frame are indicated, and their relationship to the television field and frame can be compared. The pull-down cycle for each film frame is completely masked by the shutter, so that no travel ghost will be evident in the projected picture. The shutter in this modified projector produces 5 light pulses of 2770 μsec duration for each film frame, 4 per television frame, or 2 per television field. The application time then for each television field is 5540 μsec.

The shutter is of the barrel type and rotates at 3600 rpm. The shutter and its gear train are the principal mechanical modifications to the Design 614; gear centers and bearings are not affected.

The light output of this projector, modified for television use, is approximately 50 lm, using a 300-w lamp at its rated voltage. Allowing for losses in the multiplexing system, which account for approximately 80% of the light loss in most systems, adequate light is available for the proper illumination of the vidicon target, which requires approximately 300 ft-c. The target size is $\frac{1}{2}$ in. × $\frac{3}{8}$ in. so that the total target illumination required is less than 1 lm. Using 750- or 1000-w lamps at reduced voltages would extend lamp life, or at rated voltages would provide adequate light for color systems; 200-hr, 750-w lamps have been found to give excellent results at 73-lm light output.

The projection lamps are very easily changed. The lamp is located under a hinged cover which snaps open and fully exposes the projection lamp. Lamps are of the medium prefocus-type T-10 or T-12 bulbs.

The exciter lamp for optical sound reproduction is located under a cover secured by one thumbscrew. The socket lamp is of the quick release type; a push of a convenient lever releases the lamp for ready removal.

It was felt that a modern television projector should also have provision for magnetic playback as well as normal photographic playback. A soundhead was under development at Bell & Howell which would have magnetic facilities; this soundhead was incorporated into the 614 Television Projector. The soundhead has the normal optical system and film transport, and, in addition, has a magnetic playback head which is located in the position which meets the proposed SMPTE standard of 28 frames ± $\frac{1}{4}$ frame ahead of the picture. The soundhead characteristics as an optical reproducer are the same as those for the JAN projector. The magnetic reproduce characteristics are equal to the optical characteristics with both flutter and wow being less than 0.25%. The magnetic frequency response is the same as the optical response at the higher frequencies.

The SMPTE magnetic multifrequency film is used as a signal source. The system noise is better than 45 db below the output from a fully modulated (3% distortion) magnetic track. The optical signal-to-noise ratio is 60 db.

Simple and rapid maintenance is a requisite for this type of equipment. The amplifier components are easily accessible by removing the rear access panels. Resistors and capacitors are terminal-strip mounted. All component and circuits are easily accessible for service. All the components used have large safety margins so that long life is obtained.

Removal of the amplifier exposes the rear of the projector mechanism. The synchronous motor used for driving the unit is located in the lower right-hand corner of the projector mechanism and is mounted with four screws to facilitate servicing. Electrical connections are terminated in an octal plug. The vent motor is also easily changed for service. Unit construction in the mechanism reduces down time to a minimum should service be required.

Remote control of this projector is quite easily accomplished, since the machine has its own changeover system for both picture and sound changeover. Control of the changeover is terminated at a 4-pin receptacle on the front of the projector and can easily be extended to the camera-control position for remote operation. The projector is reversible and this function can also be made a remote operation.

Projectors of this type are now in production and are currently in use in a number of television stations. The Bell & Howell 614 CBVM projector fills a gap in film chains for lower cost installation without reducing performance quality. It has all the facilities necessary for good television film programming. Magnetic-playback facilities on a telecine projector give the small or large television station an added program tool. Magnetic striping of 16mm film is now practical for newsreels, on-the-spot motion pictures, commercials, etc. Means for adding stripes to film are available as a service, or machines may be obtained from several manufacturers so that television stations can do their own film striping. Program material via this medium is only limited by the imagination of the production people.

# Another Armat Intermittent Movement

By ALEXANDER J. WEDDERBURN

**A fourth mechanism by Thomas Armat for intermittently moving film through a motion-picture projector has recently been discovered in his old workshop. The movement was designed for a 17.5mm projector intended for home use.**

THE NAME of Thomas Armat is a familiar one in the history of motion pictures. His pioneer work in motion-picture projection methods provided one of the basic patents in the field which became the basis for modern screening techniques.* Armat's use of the "star-wheel" or Geneva cross to move film intermittently through the projector was the first practical answer to the deadly screen flicker that retarded progress of the motion-picture industry.

What is not generally known is that Armat, far from resting on his laurels, continued his experiments with intermittent movement long after his Geneva cross had been accepted as one of the basic patents of the motion-picture industry. Only last summer was it discovered that Armat had perfected a fourth mechanism for advancing the film through the projector with a stop-start motion.

Mrs. Thomas Armat widow of the Washington inventor, while going through material stored in a small building that had formerly been Armat's workshop, came across a small projector that had been forgotten with the passage of the years. Sight of the machine brought back a flood of memories. Mrs. Armat recalls the details of a little-known episode in the life of the inventor. This is the story.

A contribution submitted on May 16, 1955, by Alexander J. Wedderburn, Div. of Graphic Arts, Smithsonian Institution, Washington 25, D. C.

* U.S. Pat. No. 578,185, March 2, 1897; see also Thomas Armat, "My part in the development of the motion picture projector," *Jour. SMPE 24:* 241–256, Mar. 1935.

After the Edison interests had acquired rights to manufacture his Vitascope projector in 1896 Armat became interested in the potential market of amateur cinematography. Foreseeing that eventually the motion-picture camera and projector would attain equal prominence in the home with still apparatus, Armat began work on a machine he believed would appeal to the amateur.

He recognized the obvious fact that 35mm machines were too cumbersome, complex and expensive for any but the professional cameraman. With this in mind he set out to produce a camera and projector, small, simple to operate and inexpensive—in short a motion-picture prototype of the Eastman Number I Kodak camera that had brought photography into millions of homes.

Armat commenced this undertaking in 1911 and by 1916–17 had worked out a rough model of a projector which met the specifications he himself had set for it. To cut size and cost of operation simultaneously Armat decided to reduce the film size and accomplished this by simply

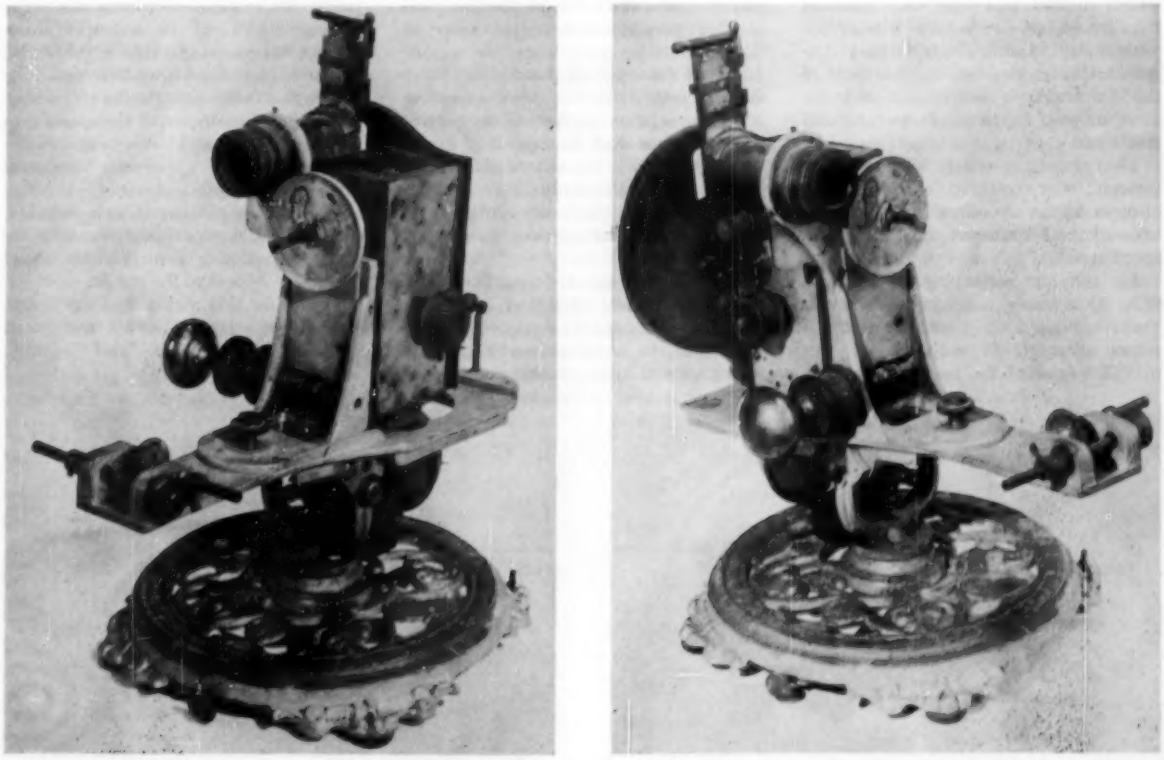

**Fig. 1. Recently discovered 17.5mm motion-picture projector made by Thomas Armat about 1916–17. Rectangular metal housing contains the intermittent mechanism. The machine was intended for amateur use.** *(Photographs from the Smithsonian Institution.)*

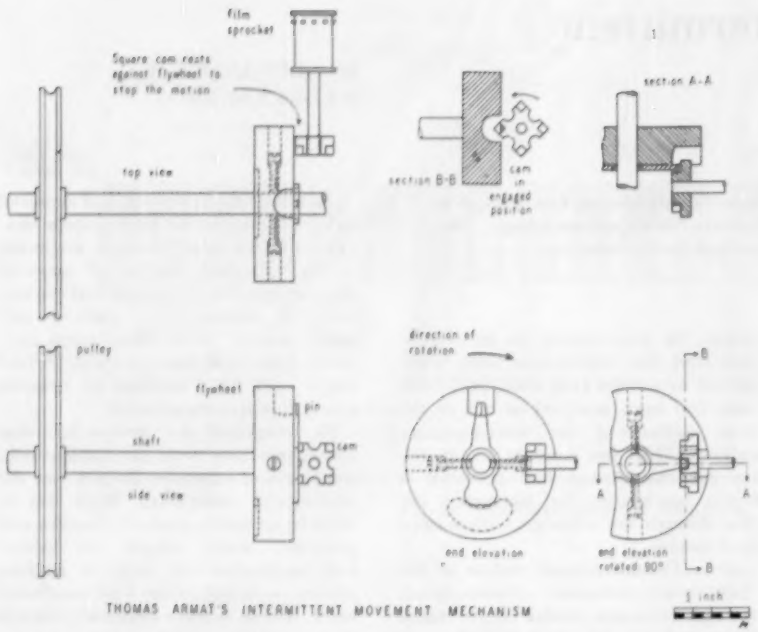


**Fig. 2. The projector contains a type of mechanism not identified previously with Thomas Armat. A pin on the flywheel strikes a square cam rotating it one-quarter turn and advancing the film a frame at each revolution of the flywheel. Between times the cam is locked at rest against the face of the flywheel.** (*Photograph from the Smithsonian Institution.*)

cutting a roll of 35mm standard-size film down the middle. This gave him a length of film 17.5 mm wide with an effective image size near to that of the present-day 16mm film. Of course the sprocket holes ran only on one side of the film and both camera and projector were adapted mechanically to meet this condition.

The projector, which is of primary interest, was powered with a small electric motor. A motor speed control allowed the operator to change the film speed at will.

In the accompanying illustrations (Fig. 1) Armat's amateur projector is shown mounted on a circular pedestal whose diameter is only 11 in. The overall height of the machine is 15 in. and its longest measurement is 14 in.

But the most significant aspect of this machine was disclosed for the first time since it was reluctantly laid away in 1926 by its inventor when the author removed the top plate that hid the intermittent movement. We were expecting to uncover the familiar Geneva cross which Armat had incorporated in his 1896 projector. Instead we found a mechanism considerably different from any of the three previously attributed to Armat and/or his onetime partner C. Francis Jenkins.

It will be remembered that Armat and Jenkins together designed the first device that eliminated the screen flicker. This was the so-called mutilated gear which proved to be too noisy and heavy to be practical. This was in 1895. Later that year after dissolution of the partnership with Jenkins, Armat adapted an eccentric cam or beater movement to his Vitascope projector. This too proved not to be the full answer because the constant striking of the beater tended to break the film.

It was in 1896 that the now famous Geneva cross movement was introduced in Armat's second Vitascope. This so far as was known until last year, was the last of Armat's improvements in the field of intermittent mechanism. Now we know that Thomas Armat was one of those inventors who never assumed that his most recent effort could not be improved upon. Apparently he decided to use still another stop-start device for his amateur projector.

As may be noted in the accompanying drawing (Fig. 2) the film sprocket is on a drive shaft which advances the film one frame at a time with a stop-start motion. The intermittent movement is imparted when a pin on the flywheel of the main drive shaft engages a square cam on the sprocket shaft, rotating it one-quarter turn and advancing the film a frame at each revolution of the flywheel. Between times the cam is locked at rest against the face of the flywheel providing a period of rest for each frame of the film.

This machine, together with its companion piece, a 17.5mm motion-picture camera, was to have been offered to the public for amateur use under the name "Fireside Movies," according to Mrs. Armat. But Armat and Henry N. Marvin, of the American Mutoscope and Biograph Co. who was to have been a partner and promoter of the new Company, lost interest in the project when they learned of apparently successful attempts by Edison and others to produce sound motion pictures. Unaccountably, they came to the conclusion that with the advent of sound a silent machine would have little appeal to the public.

It was for this reason that the fourth intermittent movement by the noted inventor was laid aside and forgotten until its recent discovery by the author.

# Motion-Picture Studio Lighting and Process Photography Committee Report

By PETRO VLAHOS, *Committee Chairman*

A MAJOR CHANGE in motion-picture studio lighting has taken place in the last two years. The introduction of color film balanced for incandescent light showed promise of reducing light levels on motion-picture sets. The 400 ft-c used for the daylight film was reduced to about 200 ft-c for the incandescent light color film.

These low illumination levels did not last very long because a whole chain of events began to occur. CinemaScope presented the big picture and theaters installed big screens. Other types of wide-screen pictures were also shown. While definition, sharpness, grain and depth of field had been reasonably satisfactory on the small screen, the greater magnification necessary to fill the large screen made it quite apparent that the big-screen picture needed some improvement.

Better lenses were developed, and an additional improvement was obtained by raising the light level on the set to permit stopping down the camera lens. A second effect of the big screen was the possibility and desirability of increasing the scope of the scene. This led to the use of larger sets. The larger sets, however, generally increase the depth of field being photographed. To carry the increased field depth, the camera lens is stopped down and this again raises the required light level.

To obtain better grain and sharpness, larger negative areas are used. By using all the available area on a standard 35-mm film with a 4-hole pulldown, CinemaScope realizes an increase of 32% in net area on the negative, and VistaVision doubles the area of the negative by using a double frame. The larger negative size improves the sharpness and reduces the apparent grain; for a given lens angle, however, a longer focal length lens is required which reduces depth of field. Again the light level on the set is increased to permit stopping down the lens. By this time the average light level on the big sets is from 850 to 1000 ft-c and sometimes higher.

An interesting statistic is the growth in the number of 10-kw lighting units. Since their introduction in 1922 the number of 10-kw units has steadily increased. In January of 1953 there were approximately 600; a year later there were approximately 1000 of these units and in January of this year there were nearly 3000 10-kw units in use.

The demand for more light has accelerated the development of new light sources and improvements in standard light sources. General Electric has redesigned a number of its studio-type incandescent lamps to make them noise-free when operated on alternating current.

The National Carbon Co. has developed a new studio lighting carbon having an incandescent color temperature. It is a 16mm high-intensity, 225-amp, yellow flame carbon, having a spectral energy distribution approximately that of the 3350 K incandescent lamp. This new carbon requires only a very light filter to absorb a slight excess of near ultraviolet. Arc lamps burning the new carbon produce more than twice as much light as 10-kw incandescent-lamp equipments. For a set that is rigged with 200 or more 10-kw incandescent lamps, something more powerful is required for the key light and for simulating the effect of sunlight. The yellow carbon satisfies this need and is already being used in motion-picture production. A more complete report on the yellow carbon is expected from the National Carbon Co.

The use of higher light levels has also raised the light-level requirements of other production equipment such as the process projector and the follow-spot.

The Motion Picture Research Council has developed a new condenser relay system, operating at $f/2.0$. This system is being used in process projection, the first application having been made on a projector using a VistaVision double-frame aperture. This optical system delivers 30,000 lm to the screen through a VistaVision aperture, a 50% shutter and an $f/2$ lens, using a 16mm carbon. With a 13.6-mm Ultrex carbon burning at 270 amps, the output is 42,000 lm. The field is over corrected to provide more light at the edges of the screen than at the center to help compensate for the screen fall-off as seen from the camera position.

A similar condenser system and a variable focal length objective lens were developed to improve the light intensity of the follow-spot lamp. This lamp delivers a uniform spot of light 10 ft in diameter at any distance from 30 to 70 ft and at a constant intensity of as high as 1200 ft-c.

This Committee can report that upon the basis of present techniques, the motion-picture producing industry would welcome, among other things, a faster fine-grain color film, light sources with less heat, a simple effective traveling-matte process and a high-gain transparency screen, providing uniform brightness to the camera.

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Presented on April 22, 1955, at the Society's Convention at Chicago by Petro Vlahos, Motion Picture Research Council, 6660 Santa Monica Blvd., Hollywood 38.
(This report was submitted on July 26, 1955.)

# Annual Meeting — 1955

A number of amendments to the Society's Constitution and Bylaws have been duly considered by the Board of Governors and are proposed here for discussion during the 1955 Annual Meeting of the Society which will be held at the Lake Placid Club, Essex County, N.Y., at 10 A.M. Monday, October 3, during the 78th Convention.

## Constitution and Bylaw Amendments Proposed

Constitutional amendments will be circulated by letter ballot to all voting members of the Society immediately following the 78th Convention. A period of 60 days is then allowed for return of the ballots.

Bylaw amendments must be published, as they are here, in advance of the annual meeting, considered during the meeting, and, if approved there by two-thirds of the voting members on hand, in the presence of a quorum, are adopted. If a quorum, currently 134 voting members, is lacking, they will be referred to the Board of Governors for final action.

A complete transcript of the current Constitution and Bylaws is contained in the April 1955 *Journal*.

Although the Society, through its Student Chapters and in other ways, has been serving an educational function, the word "education" does not appear among the Society's official objects. It is recommended that the words shown in italics be inserted as indicated.

**ARTICLE II:** "Its objects shall be: Advancement in the theory and practice of engineering in motion pictures, television, and the allied arts and sciences; the standardization of equipment and practices employed therein; the maintenance of a high professional standing among its members; *guidance of students and the attainment of high standards of education;* and the dissemination of scientific knowledge by publication."

As mentioned elsewhere in this issue, in the report of the July meeting of the Board of Governors, it is proposed that a new office of Sections Vice-President be created. To do so and to permit that officer to carry out his duties, the following two constitutional changes and changes to Bylaws III, VII, XI and XII are proposed.

**ARTICLE V:** Add the italicized words as indicated "The officers of the Society shall be a President, an Executive Vice-President, a Past-President, an Engineering Vice-President, an Editorial Vice-President, a Financial Vice-President, a Convention Vice-President, *a Sections Vice-President*, a Secretary, and a Treasurer."

**ARTICLE VII:** Change the word "five" to read "six."

**BYLAW I Section 3(c)** presently stipulates that applicants for Active membership must submit as references the names of two members of the grade applied for or of a higher grade. This presents difficulties to many otherwise qualified applicants and a majority of the Board of Governors felt that there would be no reduction in the caliber of applicant if this number were reduced to one. It is proposed that the word "two" be deleted and replaced with the word "one."

**BYLAW III Section 3** states that a quorum of the Board is ten. The proposal to amend Bylaw XI would, if adopted, provide for variations in the size of the Board, depending upon the number of Sections that qualify for ex-officio representation, and it therefore seems desirable to state the quorum as a percentage figure. It is proposed that the word "ten" be deleted and replaced with "two-fifths of the."

**BYLAW V:** The Society has had an Executive Committee which assists and advises the President and the Headquarters in matters of policy and operations. It is proposed that the Executive Committee be formalized by adding the following as a Section 7 to this Bylaw: "There shall be an Executive Committee, composed of the President, Executive Vice-President, Financial Vice-President, and one other officer appointed by the President, to review regularly, the operations of the Society, plan the forthcoming budget, and carry out assignments of the Board of Governors."

**BYLAW VII Section 3:** It is proposed that the word "seven" in the first paragraph be deleted and the word "eight" be inserted, and that a "Paragraph (f)" be added as follows "The Sections Vice-President shall coordinate and be responsible for administration of the affairs of Sections and Student Chapters and shall help these groups by interpreting Society policy, and assisting in the planning of meetings. He shall also aid in the formation of new Sections and Student Chapters."

It is proposed also that Section 6 be deleted in its entirety, as being a provision more properly spelled out in the Society's Administrative Practices.

**BYLAW IX:** To make the Student membership year correspond more nearly with the school year, it is proposed that the first sentence of Section 1 be changed to read "...Associate members, payable on or before January 1 of each year, and five dollars ($5) for student members, payable on or before October 1 of each year."

**BYLAW X** states that the *Journal* shall appear in two volumes per year, but this is clearly impractical with the *Journal* now in its large page size, so it is proposed that the words "in two volumes per year" be deleted.

**BYLAW XI** presently makes all Section Chairmen ex-officio national governors. The Board believes that formation of new Sections should not provide for automatic Board representation, but that Sections should earn such representation by their performance. The following modification of Section 4 is proposed as a practical way of providing for this modification. "The officers of each Section shall be a Chairman and a Secretary-Treasurer. When the technical quality of the presented papers, and the average attendance at meetings reaches a satisfactory level, the Board of Governors may authorize that the Section Chairman become ex officio a member of the Board of Governors. Each Section officer shall hold office for one year, or until his successor is chosen.

Under **Section 9 of BYLAW XI,** delete "Secretary" and substitute "Sections Vice-President."

**BYLAW XII Section 5:** Delete the word "Secretary" and substitute the words "Sections Vice-President."

**BYLAW XII Section 7:** Delete the word "Secretary" and substitute the words "Sections Vice-President."

# 78th Convention. . . . . .

**Lake Placid Club, Essex County, October 2–7, 1955**

The Convention announcement mailed to members early in August gave the line-up of sessions and an extensive list of social activities, even more varied than usual because we will very nearly have the Lake Placid Club to ourselves. We can pull the rafters down if we want to — well, figuratively.

### Rooms and Registration

Members received with their announcement of the Fall Convention, two return post cards, one for advance Convention registration addressed to J. C. Naughton, National Carbon Co., 632 Oliver Bldg., Pittsburgh 22, Pa., and the other for hotel room reservation addressed to Daniel M. Nelson, Lake Placid Club, Essex County, N.Y. A footnote to the room rate schedule given in the card and in the June *Journal* is that children under 12 are rated at $10.00 a day.

The Lake Placid Club has arranged to serve guests who are not registered there at these rates during the Convention: breakfast, $1.75; luncheon, $3.50; dinner, $4.50; banquet (Thursday), $5.00; or the three daily meals, $8.65, gratuities included.

The Hotel Marcy in Lake Placid attracted a few SMPTE members during the Convention in 1950, and nowadays it is reported there are also numerous motels near enough for 78th Convention stopovers.

As a new service to visitors, maps of the Club and grounds will be available at the Registration Desk, made up in 8 × 10 size by Johnny Stott.

### Informal Dress

Emphasis will be on informality. Bring some casual but warm clothes for a possibly cold, snappy evening or two.

Dress for meals under the Society's American Plan arrangement (meals included) will be quite informal — no jackets required for breakfast or luncheon; ties and coats are to be worn at dinner. All Convention guests will be served in the Club's Forest East Suites, the SMPTE Dining Room.

### Awards

Presentation of awards on Tuesday evening will be an enjoyable program with the Club orchestra on hand to introduce the ceremonies of conferring the Society's awards for this year and the inducting of a group of newly elevated Fellows. The awards are: Progress, Journal, Samuel L. Warner, David Sarnoff and Honorary Membership.

### Ladies Events

In addition to the entertainment detailed below, and in which the wives of members and guests are cordially invited to participate, there will be a number of special events for Ladies Only, including a Buffet Luncheon on Tuesday; for those inclined toward golf, a putting match (novices welcome); a picnic on Wednesday; on Thursday morning, a boat ride on Lake Placid; and Friday afternoon, a Farewell Punch Party. Registration for Ladies opens on Sunday at 2:00 P.M.; the fee will be $2.50 for the week.

### Children

Bring the youngsters this time, for the Lake Placid Club is an ideal place for them to become acquainted with the inner workings of SMPTE. They too are most welcome. For them, in addition to the generous array of sports facilities, there are of course the pre-release feature pictures, picnic, etc. Children need not register and for them there is no Convention fee.

### Entertainment

In the Advance Program below are included the major entertainment events. In addition there will be a golf tournament, and the Lake Placid Club is of course also famous for its other sports facilities, tennis, boating and swimming.

On Wednesday evening Dick Bird will illustrate and describe his lifelong work photographing birds and small animals around the world — a special highlight for the Convention week.

The Country Dance on Thursday evening requires comic or bucolic costumes — no formals allowed — prizes for the best country-dressed man, woman and couple, and for the funniest costume. Your costume is to be worn at the cocktail party preceding the dinner.

Then there will be music, some mountain-type, for dancing 9:30 to 12:30.

All entertainment is included in a single entertainment ticket costing $7.50, which everyone will want.

From Sunday to Saturday members and their guests, who are most welcome, will find prepared a thorough bill of fare of science, technology, chatter and recreation.

### Business Meeting

Several proposals for amendment of the Society's Constitution and Bylaws have been developed by the Board of Governors and have been approved for consideration at the 1955 Annual Meeting of SMPTE. The proposals are detailed elsewhere in this issue of the *Journal*. The meeting will be held at 10:00 A.M., Monday, October 3, in the Agora Auditorium of the Lake Placid Club.

### Papers Program Committees

Under Papers Committee Chairman Ralph E. Lovell, the Vice-Chairmen now serving are: J. E. Aiken, S. W. Athey, G. G. Graham, C. E. Heppberger, Petro Vlahos, J. H. Waddell.

*The Active Committee for 78th Meeting* which arranged the Papers Program is:

*Glenn E. Matthews*, Program Chairman

*Gordon A. Chambers*, in charge of Laboratory Practice Session (assisted by *John G. Stott* who coordinated papers on Materials and Solutions)

*Charles R. Daily*, in charge of Projection and Viewing Session (assisted by *Fred J. Kolb*, coordinator for roundtable on Projection for the Large Screen)

*T. Gentry Veal*, in charge of Television Practice Session

*Petro Vlahos*, in charge of Studio Practice Session

*John H. Waddell*, in charge of High-Speed Photography Symposium

### Convention Planners

Arrangements now nearing completion are under the capable direction of this roster of chairmen and committee members appointed by Byron Roudabush, Convention Vice-President:

*Local Arrangements*
*Chairman*, Donald E. Hyndman

*Registration*, J. C. Naughton, Chairman
William Westphal, Auditor
Marie M. Lucas, Assistant

*Hotel Arrangements*, Louis Feldman

*Projection*, William Hecht, Chairman
James Moses, Assistant

*Public Address and Recording*, J. V. Leahy

*Hospitality*, Garland C. Misener

*Publicity*, Sue Grotta

*Banquet and Awards Session*, John G. Stott

*Entertainment*, Reid H. Ray, Chairman
Earl I. Sponable
Frank Cahill

*Membership*, Joseph E. Aiken

*Ladies Committee*, Oscar F. Neu

*Cohostesses*—Mrs. Donald E. Hyndman and Mrs. Earl I. Sponable

*Golf Committee*, W. T. Hanson, Jr.

*Administrative Assistant*, William H. Metzger

### Motion-Picture Short Subjects

All technical sessions will open with short subjects in color that Ed Stifle of Eastman Kodak has obtained through the great generosity of these major film companies.

Warner Brothers Pictures Corp.
*Heart of an Empire* (CinemaScope)
*Journey to the Sea* (CinemaScope)

Columbia Pictures Corp.
*When Magoo Flew* (cartoon)
*Gerald McBoing-Boing* (cartoon)

Twentieth Century Fox-Film Corp.
*Survival City* (CinemaScope)
*Tears of the Moon* (CinemaScope)

Metro-Goldwyn-Mayer Pictures Corp. (through Loew's Inc.)
*Tom and Cherie* (CinemaScope cartoon)
*The First Badman* (cartoon)

RKO Radio Pictures Inc.
*Flying Squirrel* (Disney cartoon)
*Beezy Bear* (Disney CinemaScope cartoon)

Paramount Pictures Corp.
*VistaVision Visits Hawaii*
*VistaVision Visits Norway*

# ADVANCE PROGRAM

*The schedule is now set with but a few last-minute changes possible in the Final Program, which you will receive at the Registration Desk. If you must pinpoint your time for a single session or a group of papers, better check in advance with the Program Chairman, Glenn E. Matthews, Research Laboratories, Bldg. 59, Kodak Park, Rochester 4, N.Y., or with Society Headquarters.* Expectations are that it will be a full week for most registrants because the sessions are all substantial and the recreation opportunities and entertainment events will be a welcome balance.

**EQUIPMENT EXHIBITS**

Convention Vice-President Roudabush has announced that there will be space available to authors at the entrance to the Sessions Room for exhibits, which are to be put up only during the session. *The space will be in relation to the papers, and all signs must relate to papers, not to companies.*

## SMPTE 78th Convention

## October 2–7 1955 — Lake Placid

**SUNDAY OCTOBER 2**

**Registration for the Convention will be opened early — at 2:00 P. M., in the Lake Placid Club's Octagonal Bay overlooking the Lake. 8:00 P. M., Wide-Screen Pre-Release**

**MONDAY OCTOBER 3**

**9:00 A.M., Convention Registration**

**9:30 A.M. Opening Remarks**
**JOHN G. FRAYNE, SMPTE President**

**BUSINESS MEETING**

**9:45 A.M. MATERIALS AND STANDARDS SESSION**

**Polyester Photographic Film Base**
D. R. WHITE, C. J. GASS and E. MESCHTER, *E. I. du Pont de Nemours & Co., Inc., Parlin, N.J.*
Properties of "Cronar" polyester photographic film base are outlined. The utility and importance of these characteristics in the use of photographic films, especially cine films, are discussed. Optical clarity, high wear and tear resistance, low moisture sensitivity and relatively high stiffness modulus combine to make this base an excellent one for general use, and particularly useful in certain demanding situations.

**Science and Technology in Color Motion-Picture Photography**
C. J. STAUD, *Eastman Kodak Co., Rochester, N.Y.*
A brief review is given of some of the technological problems which confront those doing development work in the field of films for color motion-picture photography. An outline is given of a few of the fundamental problems related to this field from the standpoint of the science of color photography.

**A Chairman Looks at Stockholm**
AXEL G. JENSEN, *Bell Telephone Laboratories, Inc., Murray Hill, N.J.*
Dr. Jensen was Chairman of the Cinematography Sessions and a member of Technical Committee 36 at the International Standardization Organization Meeting in Stockholm, June 11–16, 1955.

**Progress Toward International Motion-Picture Standards**
D. R. WHITE, *E. I. du Pont de Nemours and Co., Inc., Parlin, N.J.*
Dr. White headed the United States delegation of Technical Committee 36 at Stockholm.

**12:00 NOON, PANORAMA PHOTOGRAPH will be made of the Convention Group**

**2:00 P.M., STUDIO PRACTICE SESSION**

**An Evaluation of Certain Methods of Using Exposure Meters**
L. SOREM, *Eastman Kodak Co., Rochester, N.Y.*
Five methods of measuring some aspect of scene luminance or illumination have been used in photographing sixteen outdoor and eight indoor scenes. An exposure series was made for each scene on two motion-picture negative films. By comparing the exposures which yielded optimum print quality with those indicated by the five different exposure meter techniques, each technique was evaluated and the consistency with which high-quality results could be obtained was determined.

**A 225-Ampere Motion-Picture Studio Carbon for Use With 3200–3400 K Color Film**
F. P. HOLLOWAY, C. A. PLASKETT and R. B. DULL, *National Carbon Co., Fostoria, Ohio;* and C. W. HANDLEY, *National Carbon Co., Los Angeles.*
A 16mm Super H. I. Color-Modified Studio carbon, designed for use with 3200–3400 K color film, has been developed for set lighting and process projection in motion-picture studios. At 225 amp the new carbon has a spectral energy distribution approximating that of the 3350 K incandescent lamp. No filters are needed when a set is illuminated entirely by the color-modified carbon, as proper balance can be obtained during film processing. Only a light filter is required to absorb an excess of near ultraviolet radiation to permit the use of mixed incandescent and arc light on motion-picture sets. No filtering is needed for process projection when a relay condenser type optical system is employed.

**Production Evaluation of the 225-Amp Low Color Temperature Carbon**
W. F. KELLEY, *Motion Picture Research Council, Los Angeles.*

**Color in Television Studio Lighting**
R. G. WILLIAMS, *Century Lighting Inc., New York.*
Control of the spectral quality of television studio lighting will be discussed as a means of producing accurate color rendition in the television picture. Spectral distribution of light in relation to vision, color perception and picture color rendition will be explained. Spectral characteristics of certain light sources in relation to studio lighting will be reviewed. The unsuitability of degrees Kelvin as a guide to spectral quality will be proposed. The possibilities of "variable color" in studio lighting will be outlined.

**A New Hand-Held Lightweight Double-Frame VistaVision Camera**
*Paramount Pictures Corp., Hollywood.*

**ROUNDTABLE DISCUSSION: Color Motion-Picture Production Problems**
*Speakers:*
W. A. MUELLER, *Warner Bros. Pictures, Burbank, Calif.*
L. L. RYDER, *Paramount Pictures Corp., Hollywood*
DOUGLAS SHEARER, *Metro-Goldwyn-Mayer Studios, Culver City, Calif.*

### Tentative Schedule of Committee Meetings During Convention

*Monday, October 3*
1:30 P.M. PH22
3:30 P.M. 16 & 8mm
*Tuesday, October 4*
10:00 A.M. Television
10:00 A.M. 79th Convention Arrangements
1:30 P.M. Color
1:30 P.M. 80th Convention Arrangements
3:30 P.M. Film Dimensions
*Wednesday, October 5*
10:00 A.M. Magnetic Recording
10:00 A.M. Papers/79th Convention
1:30 P.M. Sound
3:30 P.M. Film-Projection Practice
*Thursday, October 6*
10:00 A.M. High-Speed Photography
1:30 P.M. Laboratory Practice
*Friday, October 7*
10:00 A.M. Screen Brightness

*Final schedule will be listed in the Convention Program and meeting notices will be mailed directly to committee members.*

E. I. SPONABLE, *20th Century-Fox Film Corp., New York*
Economic, operational and engineering aspects of recent changes in major studio production practices brought about by wide-screen presentations, and in some cases conversion for large scale television film production, will be analyzed by several of Hollywood's leading engineers as contributing members of this panel.

**MONDAY EVENING**

**6:00 P.M., Treasure Hunt and Barbecue**

**TUESDAY MORNING OCTOBER 4**

**9:00 A.M., PROJECTION AND VIEWING SESSION**

**New Concepts of Perspecta Sound and Projection Control Practice**
R. A. HAINES, *Far East Army and Air Force Motion Picture Service, APO 500 (Tokyo, Japan) San Francisco, Calif.*
Development concepts and assembly details are described for new custom-designed perspecta integrators and projection control devices being employed throughout the largest overseas American military theater circuit serving in the Far East. Featuring capability of full-time employment of 3-channel directional sound reproduction in operation from any photographic film-track or other signal source, the integrators combine provisions for simplified operation, complete emergency switching to prevent sound failure, and extreme service accessibility. The new semiautomatic dual pushbutton controller is an original, unique idea which achieves maximum centralization of all operational controls to facilitate handling by one military projectionist. More than one hundred sets of these equipments are being installed in Far East Army and Air Force Theaters.

**New Field Developments for Military Theater Circuit Modernization**
R. A. HAINES, *Far East Army and Air Force Motion Picture Service, APO 500 (Tokyo, Japan) San Francisco, Calif.*
In planning and implementing a comprehensive program of 35mm equipment modernization for the largest overseas U.S. military theater organization, several new and unique field

developments have been undertaken successfully. Sincere, studied efforts were made to raise exhibition standards to equal or exceed best present practices while, simultaneously, simplifying and centralizing operational requirements for military projectionists to assure professional presentations. Bases for the selection of standards, and some details of practical application of the special equipment are described as practiced by the 120-theater Far East Army and Air Force circuit. Application of some of these achievements, if not necessarily commercial in present form, could provide useful prototype guideposts to possible trends of the future.

**A Noncommercial Participation-Type Theater**
ARTHUR L. SMITH, *Colonial Williamsburg, Williamsburg, Va.*

**A New 8mm Copper-Coated Carbon for Motion-Picture Projection**
F. P. HOLLOWAY and R. B. DULL, *The National Carbon Co., Fostoria, Ohio.*
A new 8mm, copper-coated, nonrotating positive carbon for motion-picture projection, designed for 60–70 amp operation, gives a substantial increase in light and efficiency, and an improvement in steadiness of light, over the old 8mm carbon. Light, efficiency and steadiness of the new carbon are compared with those of the old.

**This Is Cinerama**
W. ROBERT DRESSER, *Cinerama Inc., New York.*
Since the introduction of Cinerama nearly three years ago, the motion-picture industry has been eager to take a new look at the film frame and to revaluate its potentialities. The industry, as well as the public, has been rewarded by the introduction of new film presentations and sound techniques. This paper outlines the physiological factors required to give the feeling of audience participation in photographed scenes, and describes the mechanisms employed in the Cinerama process for accomplishing a desired result.

**Report of the Committee on 16mm and 8mm Motion Pictures**
M. G. TOWNSLEY, Chairman

**The New Paramount Double-Frame, Triple-Head Transparency Background Projector**
FARCIOT EDOUART, *Paramount Pictures Corp., Hollywood.*

## TUESDAY AFTERNOON
## 2:00 P.M., PROJECTION AND VIEWING SESSION

**Todd-AO Motion-Picture System**
BRIAN O'BRIEN, *American Optical Co., Southbridge, Mass.*
The Todd-AO System utilizes either 65 or 70-mm film of identical perforation operating at 30 frames/sec. Cameras weigh only slightly more than corresponding 35mm units, and are equipped with a complement of lenses of angular coverage ranging from 16° to 132°, with relative aperture ranging from $f/2.8$ to $f/2.0$. Picture aspect ratio is approximately 2 to 1, and projection is upon a large deeply curved screen with sagitta approximately $\frac{1}{4}$ the chord. The screen is illuminated by a single projector located in the rear of the theater, and of relatively conventional design with certain special features and special projection lenses to achieve very high quality images from the large film. Composite sound is provided by six high quality magnetic channels on the 70mm release print.

**Perception of Color in Projected and Televised Pictures**
D. L. MacADAM, *Eastman Kodak Co., Rochester, N.Y.*
Many color photographs are taken in daylight and projected with tungsten lamps. On the other hand, commercial motion pictures made with tungsten studio lamps are almost always projected with arcs that resemble daylight. Color television receivers produce "white" of daylight quality or even bluer, although most of the scenes televised are tungsten-lighted. Hence the question: "How should a color in one quality of illumination be reproduced for viewing with some other quality?" An investigation undertaken to answer this question will be described, and the results will be discussed.

The simple answer suggested by von Kries' law of coefficients appears to be only a first approximation. Closer analysis of the behavior of the eye seems to indicate that human color vision is served by at least four and probably by five or even six different photosensitive processes, having different spectral sensitivities and different degrees of adaptation to various qualities of illumination.

These findings do not call into question the trichromatic character of color perception, on which color photography and color television are based. Apparently the visual nervous system provides only three channels, capable of handling only three independent responses. But each of these responses appears to be stimulated by a combination of two or more photosensitive processes in the eye.

**Effects of Visual Angle on Visual Perception**
S. M. NEWHALL, *Eastman Kodak Co., Rochester, N.Y.*
If the visual angle subtended by an object is varied, as by varying the viewing distance, the perception or appearance of the object may also change. Appropriate comparisons can reveal obvious changes as in perceived size, perceptible detail, eye-comfort, apparent color and realistic effect. There are, however, several factors in commercial motion-picture viewing situations which tend to minimize differential effects of visual angle on motion-picture perceptions.

**ROUNDTABLE DISCUSSION: Projecting for the Wide Screen**

*Speakers:*
G. C. HIGGINS, *Eastman Kodak Co., Rochester, N.Y.*
A. E. NEUMER, *Wollensak Optical Co., Rochester, N.Y.*
W. BORBERG, *General Precision Laboratory, Pleasantville, N.Y.*
G. GAGLIARDI, *Stanley Warner Theaters, Englewood, N.J.*
Current trends toward larger projected images and toward a closer integration of the audience with the picture have emphasized many projection problems. Panel members will review the contributions of print image structure, mechanical film handling, and optical design to the final projected picture, considering both the theoretical approach and the practical evaluation. It is hoped that questions and floor discussion will enrich and amplify important considerations and evaluate methods of solution.

## TUESDAY EVENING
## 8:00 P.M., PRESENTATION of AWARDS
## Wide-Screen Pre-Release

## WEDNESDAY MORNING OCTOBER 5
## 9:00 A.M., LABORATORY PRACTICE SESSION

**The Testing of Plastics for Use in Contact With Photographic Processing Solutions**
B. A. HUTCHINS, *Eastman Kodak Co., Rochester, N.Y.*
The discussion will outline the considerations involved in the design and interpretation of experiments to evaluate plastic materials for use in contact with photographic processing solutions. Some of these considerations are: selection of plastic surface-area to volume ratio, preparation of the plastic sample for testing, designing the photographic evaluation and interpreting the results in a non-statistical manner. Information will be made available summarizing the results of similar tests which have been run.

**The Chemist Reduces Cost and Improves Quality of Processing**
L. E. WEST, *Eastman Kodak Co., Rochester, N.Y.*
Photographic processing involves many individual chemical processes, such as assuring adequate quality of chemicals, determining optimum storage conditions for these chemicals before and after solution preparation, assuring the maintenance of standard chemical concentrations, and "trouble shooting". Costs can be reduced by recovery of expensive chemicals and reuse of solutions after suitable treatments and concentration adjustments. Illustrations are given showing how the principles of chemistry and chemical engineering applied to the processing of motion picture film might result in low cost with high photographic quality of the products.

**A Quality Control Program for Motion-Picture Laboratories**
C. L. GRAHAM and R. T. RYAN, *Eastman Kodak Co., Rochester, N.Y.*
A quality control program for motion picture laboratories is proposed. Methods of controlling sensitometers, densitometers and printers and processing machines are described and simple graphical procedures for recording and evaluating sensitometric and chemical data are presented. The selection and storage of exposed and unexposed control stock is discussed. Some sample process control data from operating laboratories are given.

## WEDNESDAY AFTERNOON
## 2:00 P.M., LABORATORY PRACTICE SESSION

**Cleaning Motion-Picture Film**
D. W. FASSETT, F. KOLB, JR., and E. M. WEIGEL, *Eastman Kodak Co., Rochester, N. Y.*

**A Uniform Blackbody Light Source Excited by Radio Frequency**
S. C. PEEK, *Sylvania Electric Products Inc., Salem, Mass.*
The need for a new light source of greater stability, higher brightness and better uniformity is mentioned. The development program which resulted in such a lamp (which has black body radiation) is then discussed. Actual performance in a 35mm printer and a 16mm projector is presented with mention of other possible applications.

**The Design of Color Motion-Picture Printers**
J. G. STREIFFERT, *Eastman Kodak Co., Rochester, N.Y.*
The basic design considerations that must be met in designing a printer for making color release prints are outlined, placing particular emphasis on the film handling aspect, the optical aspect, and the illumination control.

**Professional Printing Techniques for Ansco Color Negative-Positive Motion-Picture Film**
KARL SCHADLICH, *Ansco, Binghamton, N.Y.*
Printing from Ansco color negative onto Ansco positive is relatively simple, but it does require certain changes in technique, equipment and timing. These requirements are described. The technique of timing for color printing with color correction filters is described with particular attention to some of the reasons why anticipated results are not always attained.

**Processing Anscochrome Motion-Picture Films for Industrial and Scientific Applications**
JOHN FORREST, *Ansco, Binghamton, N.Y.*
Anscochrome is a new 16mm reversal motion-picture film with an exposure index of 32. The film can be processed by the regular Ansco color process in the field or in the laboratories of the

manufacturer. Higher speeds can be secured for scientific and industrial applications at a sacrifice of fineness of grain and color balance by modifying the process. The processing procedure is described.

**Report of the Color Committee**
*J. P. WEISS, Chairman*

## WEDNESDAY EVENING

**8:00 P.M., "Camera Trails Along Nature Trails," an illustrated talk by Dick Bird, of Regina, Saskatchewan, Canada, outstanding photographer of birds and small animal life in North America.**

## THURSDAY MORNING OCTOBER 6

**9:00 A.M., ROUNDTABLE DISCUSSION: Problems of Network Broadcasting in Monochrome and Color**

*Speakers:*
R. E. SHELBY, *National Broadcasting Co., New York*
W. L. LODGE, *CBS Television, New York*
FRANK MARX, *American Broadcasting Co., New York*
F. A. COWAN, *American Telephone and Telegraph Co., New York*
P. B. LAESER, *WTMJ-TV, The Journal Co., Milwaukee, Wis.*

The advent of color television broadcasting and program distribution necessitated many changes in studio equipment, lighting, and techniques. Procedures had been well established for black-and-white television, but it became necessary for networks to approach large-scale color TV operations from an entirely different viewpoint. These points of view will be discussed by three prominent authorities from the major networks. The problem of transmitting color signals over a nationwide network required technological changes in every-day operations, which will be outlined and discussed in detail.

After the originating station has produced a color TV program and the common carrier has distributed it, many situations are encountered by the outlying stations. It is the responsibility of these stations to deliver adequate color signals to the ultimate user of a color receiver or a compatible signal which can be viewed on a black-and-white receiver. These problems will be discussed by a station representative who has had considerable experience and success in this field.

## THURSDAY AFTERNOON—CONCURRENT SESSIONS

**2:00 P.M., SYMPOSIUM ON HIGH SPEED PHOTOGRAPHY**

**A group of seven papers to make one or two sessions is planned by chairman John H. Waddell, with emphasis on film evaluation.**

**2:00 P.M., TELEVISION PRACTICE SESSION**

**A New Look at Colorimetry**
D. L. MacADAM, *Eastman Kodak Co., Rochester, N.Y.*

This will be a report on the proceedings of the International Commission on Illumination (CIE) which met in Zurich, Switzerland, from June 13 to 22, 1955. The status of the revision of the standard data for colorimetry will be explained and discussed. The present FCC standards for color television are specified in terms of colorimetric data adopted by the CIE in 1931. Most quantitative work on color, during the past 24 years, has been based on the CIE data. The significance of the proposed revisions in relation to that work and future work and specifications will be discussed.

**Colorimetric Problems in the Use of Film for Color Television**
H. N. KOZANOWSKI and S. L. BENDELL, *Radio Corp. of America, Camden, N.J.*

Increasing use of film for color telecasting has emphasized the need for a more critical view of the capabilities of both the film and the television system, and for a greater understanding of the colorimetric behavior of the combination. A discussion of the main problems is presented, in which operational requirements of present-day broadcasting are considered. Various attempts at the solution of these problems are examined and recommendations are suggested for further improvement in the art.

**Grainless Phosphor Screens for Television Tubes and the Light Amplifier**
F. J. STUDER, *General Electric Research Laboratory, Schenectady, N.Y.*

A luminescent coating deposited as a grainless layer avoids the diffusely scattered light associated with a conventional powder phosphor in television tubes. Such transparent phosphor screens of zinc sulfide can be made by a vapor phase reaction as will be described. With a screen of this kind, higher resolution and contrast are possible. Phosphor layers produced in this way may also be used as light amplifying screens.

**Television Vertical Aperture Compensation**
A. C. SCHROEDER and W. G. GIBSON, *RCA Laboratories Div., Princeton, N.J.*

The known ways of compensating in the vertical direction for a scanning aperture are reviewed. A new method is presented. This consists of wobbling the scanning aperture in and out of focus at a rapid rate yielding high and low resolution signals. The low resolution signal is subtracted from the high resolution signal yielding an aperture compensated, or edge enhanced, picture independent of the scanning direction. A similar method using vertical deflection wobble rather than focus wobble results in vertical aperture compensation alone. Pictures are shown to illustrate the subjective improvements obtainable using vertical aperture compensation.

**The Electronicam TV-Film System**
T. T. GOLDSMITH and J. CADDIGAN, *Allen B. Du Mont Laboratories, Inc., Clifton, N.J.*

The Electronicam TV-Film System is a scientific alliance of motion picture and television techniques created to meet the pressing need for an improved modern method of making sound films economically, speedily and with improved artistry. The basic association of the two arts is accomplished technically as follows: (1) The studio TV camera and the motion picture camera are mounted in juxtaposition to each other so that they share a common lens system, thus eliminating parallax problems. (2) An optical light-sharing device enables both cameras to receive the correct proportioned amount of light from the scene, while the two image planes are maintained in accurate focal relationship. (3) Concurrently with the recording of the scene on film, the picture is continuously monitored by the utilization of standard TV electronic monitoring techniques. The director selects his shots from each camera as if he were controlling a regular TV program. Thus, he accomplishes instantaneous editing of the whole program as it proceeds. (4) Video recording equipment simultaneously records the TV version of the program on film as a tele-transcription or kinescope. This then becomes the editing master, complete with bloop marks, wipes, fades and other effects, etc. (5) Special editing equipment enables the film from the individual cameras to be cut according to the kinescope editing master. Release prints are then made from this edited version. The equipment to be described will include both 16 and 35mm Electronicam apparatus—In addition to the technical aspects, the programming techniques will be discussed.

## THURSDAY EVENING

**6:30 P.M., COCKTAIL PARTY**
**8:00 P.M., DINNER**
**9:30 P.M.–12:30 A.M., COUNTRY DANCE**

## FRIDAY MORNING OCTOBER 7

**9:30 A.M., EDUCATIONAL TELEVISION**

**Are We Educating by Television?**
G. G. BRODERICK, *U. S. Office of Education, Dept. of Health, Education and Welfare, Washington 25, D. C.*

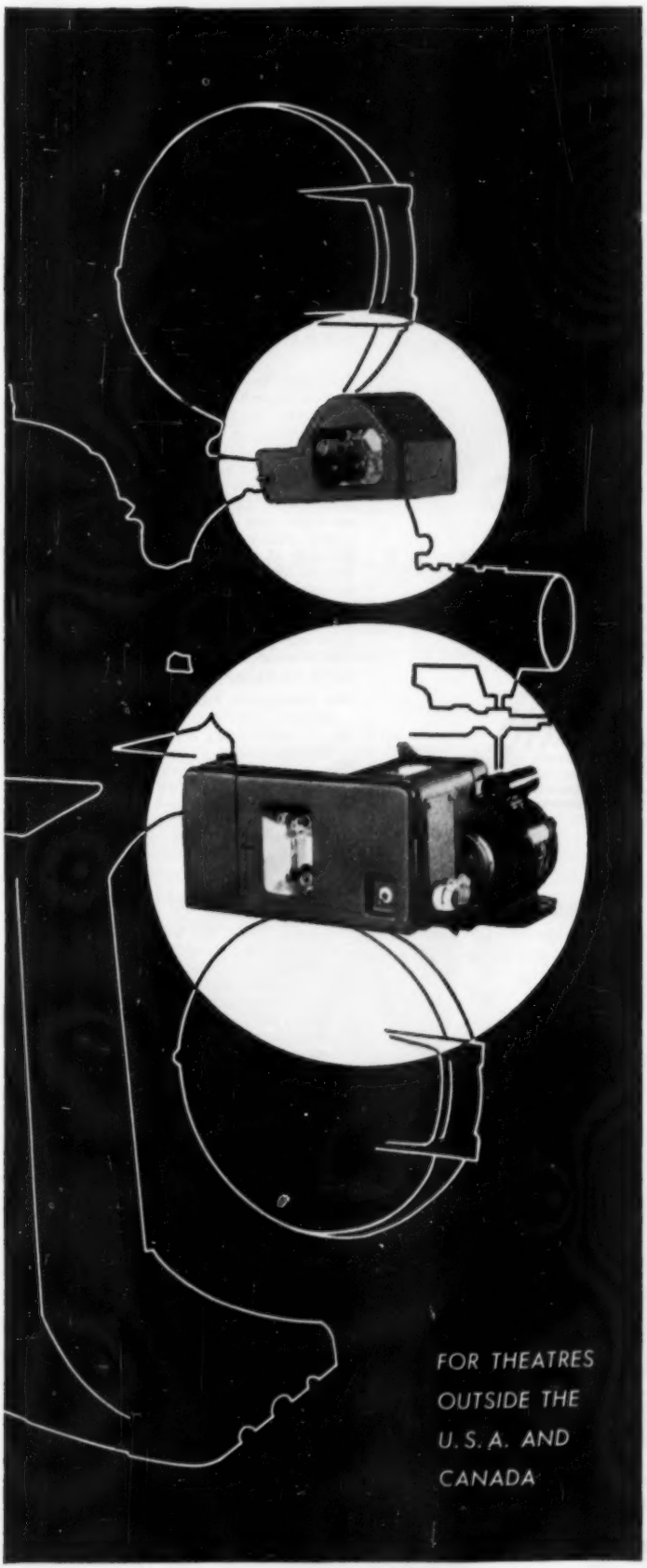
"Educational TV Growing Into Mass Movement" was the reassuring headline in VARIETY a few months ago, with a subhead adding "170 Off-the-Air Courses." Reason for the article stemmed from the release by the American Council on Education's Television Committee of a report of a survey showing a total enrollment of 12,000 students taking 170 regular academic courses of the air, as they were offered for credit by 44 different colleges and universities. The report further disclosed that in addition to accredited students, there were estimated audiences of 75,000 to 100,000 for some of the courses, bringing the total to a probable astronomical 10,000,000. This is but one illustration of the myriads of ways in which viewers today are being exposed, and are responding, to programs of genuine educational merit. There is a temptation to project this progress into a forecast of great dimensions. But our enthusiasms have already confused our colleagues and we must concentrate on the day by day progress in experimentation and assessment.

**Activities of the Joint Committee on Educational Television**
E. A. HUNGERFORD, JR., *Metropolitan Educational Television Assoc., Inc., New York.*

The Joint Committee on Educational Television is the best known organization in Educational Television circles. Its program of service to educators who wish to harness television for educational purposes extends back to 1950. It began as an *ad hoc* committee to present education's case to the FCC in a bid for reserved channels. How the Joint Committee on Educational Television acts to protect these 257 channels from encroachment, provide legal and engineering consultation to new and operating educational television stations, organizes state, regional and national conferences on educational television, provides speakers and consultants for such meetings, and distributes regular publications of news and substantive information.

**A National Educational Television Program Service**
A. M. DeLAND and L. M. NELSON, *Educational Television and Radio Center, Ann Arbor, Mich.*

Educational television today serves across the nation through sixteen non-commercial stations. The "Center" is their main source of recorded programs. In brief, the Center has a well-defined philosophy of educational television, of its own operation and of programming. The Center plans program series within the framework of an educationally sound, balanced-program structure, utilizing three basic sources for recorded programs. Maintaining and improving technical standards has been a primary object of the Center staff and program producers. To help assure high standards, the Center maintains an engineering consulting service available to TVR producers. To maintain an adequate distribution pattern, the Center has combined some audio-visual practices with the best of film editing and handling techniques.

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## 10:45 A.M., TELEVISION EQUIPMENT

**Optical Multiplexing in Television Film Equipment**

A. H. LIND and B. F. MELCHIONNI, *Radio Corp. of America, Camden, N.J.*

The primary reason for multiplexing TV film cameras and TV film projectors is economy of equipment and/or space. A further reason can be the insurance of standby protection, at a nominal cost, when continuity of programming assumes a high order of importance. The optical multiplexer described in this paper can readily satisfy both requirements when integrated into a TV Film pickup system. Technical details of the design parameters and operating characteristics are discussed.

**Inquiry Into Density Standards for Television Slides**

R. H. HILL, *Williams and Hill Ltd., Toronto.*

Characteristics of the television system—automatic distortions and compensations, alignment of equipment and the video operator, conception of the perfect waveform are reviewed. The following subjects will be considered: density characteristics of slides giving most perfect wave when chain is aligned to SMPTE test film, mean and extreme densities, balanced distribution of tonal areas, density characteristics of slide producing unsatisfactory waveforms when chain is aligned to SMPTE test film, automatic distortions and its effect on general and specific levels, limitations of reproduction irrespective of further adjustment. Controls necessary for the production of TV slides to a consistent standard will be described.

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**A Remote Control Multi-Scene Switching Preset System**

E. F. KOOK and F. M. WOLFF, *Century Lighting, Inc., New York.*

This paper describes a remote control multi-scene switching preset system for control of lighting circuits. The system incorporates both mechanical and electrical "memories". These permit a large number of circuit condition combinations to be "preset", then introduced simultaneously by depressing a single button. Combinations may also be added to one another, cancelled, or corrected as desired. The control console for a 100 circuit system is approximately the size of a standard office desk and requires only control current wiring.

## FRIDAY AFTERNOON

## 2:00 P.M., TELEVISION AND SOUND SESSION

**Television Studio Practices Relative to Kinescope Recording**

HAROLD WRIGHT, *Canadian Broadcasting Corp., Toronto, Ontario, Canada.*

If television studio practices are controlled, using the transmission waveform as the guide, consistent kinescope recording quality may be maintained. The waveform approach must be one which takes into account both peak-to-peak voltage conditions and waveform area balance. Inclusion of reference black and white in all possible shots will ensure consistent picture voltages to the kinescope recorder and permit retention of mood when the recording is reproduced. Careful attention to tonal balance of shots will produce balanced waveform areas. This is essential to stable reproduction on receivers not equipped with d-c restoration.

**The Conversion From Optical to Magnetic Sound in Television Systems**

H. C. WOHLRAB, *Siemens & Halske A. G., Karlsruhe, Germany.*

The quality improvements of magnetic sound compared with optical being well known, the differences in handling and processing will be explained. Converting optical to magnetic sound raises problems in system, equipment and organization. Ways to resolve them in already working TV systems are proposed.

**The Process of Magnetization in Magnetic Tapes**

WALTER GUCKENBURG, *Institute of Technical Acoustics, Technical University, Berlin-Charlottenburg, Germany.*

Making visible the recording on magnetic tapes by causing the layer to swell or by spreading a ferromagnetic suspension over it and an additional magnetic influencing opens a way for a better knowledge of the process of magnetization in detail. The principal method and the way of working will be explained by showing several slides.

**"Sprocketape" Recording System**

C. E. BEACHELL, *National Film Board of Canada, Ottawa.*

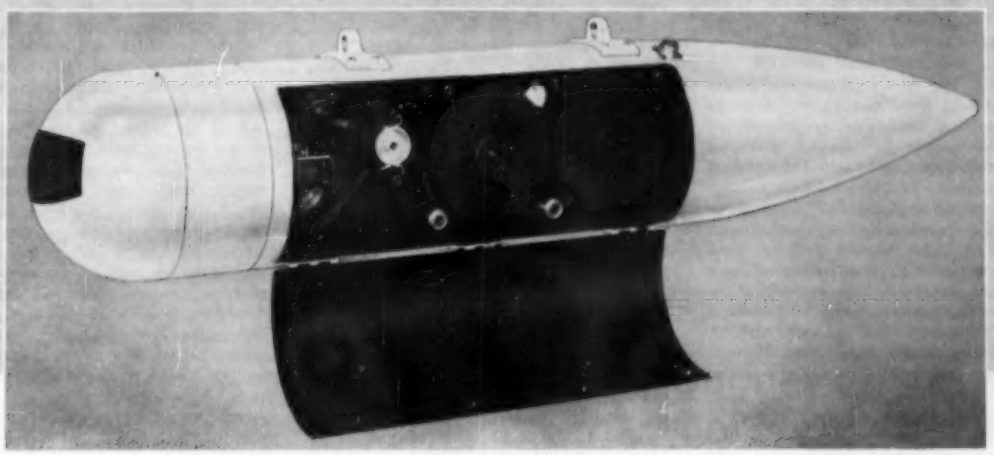
A recording system employing perforated quarter inch tape is described and demonstrated. The recorder may be buttoned-on to or interlocked with a picture camera or used as a synchronous recorder for double system. Frequency range is 30 to 9000 cycles/sec ± 1 decibel. Flutter is less than 0.1%; speed, 36 ft./min. reversible. Weight of the recorder is 12½ lb and may be carried in a brief case. Playback monitoring during recording and a silent turnover synchronizing system is provided. Recorder may be loaded with either 400 to 1200-ft. tapes mounted on cores. Techniques and equipment for editing quarter inch perforated tape are also described.

**Set Temperatures With Heat Control Coatings**

G. T. HOWARD, *General Electric Co., Cleveland, Ohio;* A. F. TURNER and H. H. SCHROEDER, *Bausch & Lomb Optical Co., Rochester, N. Y.*

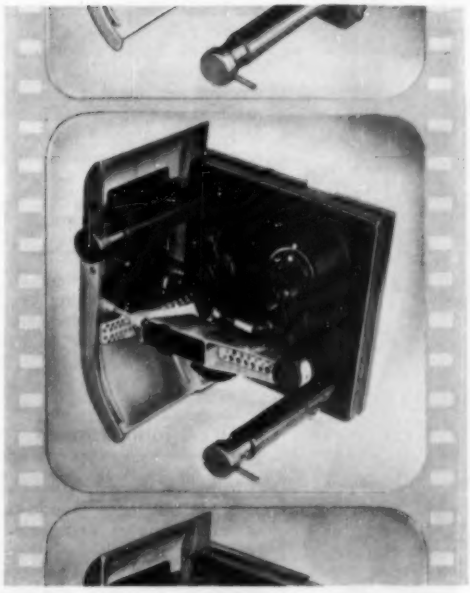
## FRIDAY EVENING 8:00 P.M., WIDE-SCREEN, PRE-RELEASE FEATURE

# PHOTO-SONICS INC.



## *70MM-5A AIRCRAFT CAMERA*

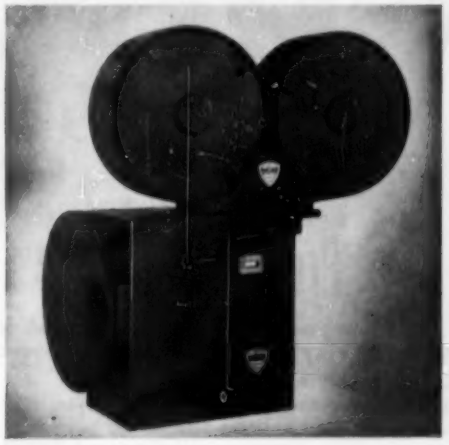
Aperture Size 1.156 x 2.25 inches—400 ft. film capacity
Film registration pins—60 frames per sec.
150 watt heater—24 volt motor



Actual frame size 70mm-10A showing photograph of film movement

## *70MM-10A CAMERA*

Aperture Size 2.25 x 2.25 inches
Film registration pins
60 frames per second
110 volt synchronous motor
Film load—1000 or 400 ft. mag.



*Additional information on request*

**PHOTO-SONICS INCORPORATED**

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## Board Meeting

During its third meeting for this year, which was held on July 28, at the Hotel Belmont Plaza in New York City, the Board of Governors reviewed current operations and made some important decisions for the future. Financial affairs were found in good enough condition to permit modest increases in second-half budget allocations for *Journal*, National Membership Committee and the national headquarters.

It was hoped that the 12% increase in budget for publication of *Journal* text pages during the second half of 1955 could be stretched to cover the use of color illustrations in places where color is essential to the understanding of technical articles. Publication of a one volume 40-year index to the *Journal* and *Transactions*, which date from 1916, the year of the Society's origin, has been variously considered during recent months. The Board felt that need for such an index had been clearly evident during recent years and asked that the Editorial Vice-President and the Editor proceed with current planning. Format and cost are to be considered.

A. G. Jensen, Engineering Vice-President, told the Board what had been accomplished by the delegates from ten nations who took part in the June meetings in Stockholm, of ISO Technical Committee 36 Cinematography. Mr. Jensen had served as Chairman of those proceedings and Boyce Nemec, SMPTE Executive Secretary, had been Secretary. Titles, numbers and disposition of all ISO-STOCKHOLM-1955 proposals on motion pictures will be published in the September issue of the *Journal*.

Recalling that the Society had at one time offered its members and others a Standards binder subscription service, which enjoyed only modest success, the Board asked that a new proposal for reinstituting a similar service, but on a changed basis, drafted by Henry Kogel, Staff Engineer, be considered in detail by Messrs. Jensen and Servies.

Arrangements for the forthcoming 78th Convention at The Lake Placid Club were reported by Byron Roudabush, Convention Vice-President, as nearing completion. He expressed the hope that attendance would be large and that a good many members would take their wives and children because special attention had created a program that would appeal to all. He said that the general schedule of events for the 79th Convention and Equipment Exhibit to be held next spring at the Hotel Statler, New York, was taking shape.

Because convention space at the more desirable locations is being obligated well into the future, it is necessary for the Convention Vice-President and the Board to fix on dates and meeting places as much as four years ahead. The commitments, through the 86th Convention, are as shown on the inside back cover of this *Journal*. Equipment exhibits are planned for the 79th, 82d and 86th Conventions.

For many years the Society has had Sections in New York, Hollywood and Chicago. There are now, in addition, four Subsections in San Francisco, Dallas, Atlanta and Western New York. It has become apparent that planning, financing and providing effective local programs for the members in these seven areas of motion-picture and television activity, is very difficult under the present organizational arrangement.

Both the incumbent and Past-Presidents of the Society have given attention to a number of suggestions for improving the organization made over many months by E. M. Stifle, Sections Coordinator, the President's advisor on section matters. Acting on Mr. Stifle's recommendations, the Board resolved to take steps necessary to create a new office of Sections Vice-President, make Sections out of the present Subsections provided they meet certain qualifications, and to grant representation on the Board of Governors, now limited to the New York, Chicago and Hollywood groups, to all Sections that reach adequate size and conduct a sufficient number of useful meetings each year. Details are presented elsewhere in this issue, along with the call for the Annual Meeting at which amendments to the Constitution and Bylaws will be discussed.

Membership has been increasing during recent months as a result of active work by the newly formed National Membership Committee under the Chairmanship of J. W. DuVall. During the first half of the year more than 600 new membership applications had been received and with the Committee likely to hit its stride early in the Fall, chances are good that 1955 will be the Society's best growth year.

Nominations for all 1955 awards were received and adopted. Presentation will be made during the Awards Session at the 78th Convention. Fellow Award certificates will be presented to D. Max Beard, Roger J. Beaudry, Charles C. Davis, Donald G. Fink, Robert M. Fraser, E. Dudley Goodale, George H. Gordon, G. Carleton Hunt, Henry N. Kozanowski, Kenneth M. Mason, J. L. Pettus, Byron Roudabush, Edward Schmidt, Robert E. Shelby, J. Paul Weiss, W. W. Wetzel and William T. Wintringham. All other recipients will be cited in a later *Journal*. —S. G.

### SMPTE Joins Acoustical Standards Board

In June of this year, the American Standards Association announced the formation of an Acoustical Standards Board and issued an invitation to the SMPTE to become a member. The Society has accepted the invitation and appointed Axel G. Jensen, Engineering Vice-President, as the Society's representative and Henry J. Hood, past Engineering Vice-President, as his alternate.

The standardization work within the American Standards Association in the broad field of acoustics, vibration, mechanical shock and sound recording has for many years been handled by two committees, Z24 and Z57. However, the growth of these activities has made necessary consideration not only of coordination but of planning for projects already under way

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and for future work. The Acoustical Standards Board has been created to supervise the work of the above-mentioned committees and to carry forward basic planning necessary for future operations.—*Henry Kogel*, Staff Engineer.

## Education, Industry News

**Credit Courses by Television** is the Report of a Conference sponsored jointly by the Committee on Television of the American Council on Education, and Continuing Education Service, Michigan State College, East Lansing, Mich., Feb. 21–22, 1955. This nearly too literal transcript of the proceedings is in 6 × 9 in. format, 50 pp., paper covered, available at the price of $1.00 from the American Council on Education, 1785 Massachusetts Ave., N.W., Room 110, Washington 6, D.C.

Many of the hopes, not all of them desperate, for subscription education television are discoursed upon by those already experienced in this new field. The economics are those of small budgets and the returns come in many degrees — or rather, there are some who really pay and work for credit toward a degree, some who buy materials, and often a large number who are pleased habitually just to look and listen in for free. Reference to the Conference Outline at the front of the booklet and some patient skimming will reward the curious.

**Origins of the Motion Picture** is a 20-min film made by the U.S. Naval Photographic Center, Washington, D.C. to meet instructional needs of the Naval Photographic School at Pensacola, Fla. Jay E. Gordon, Naval Photographic Center, acted as writer, director and supervisor of production. He has told the story by means of still photographs, original artwork, stock motion-picture footage, some footage reproduced from paper film, and live photography. Chief sources of both information and equipment were the Library of Congress and the Smithsonian Institution, with help from the Edison Foundation and from Eastman House.

The film will be released in midsummer to Navy film libraries, and prints will be offered for sale through the U.S. Office of Education.

## Obituary

**Marcel George Person,** Manager of the Westrex Company, Mexico, a subsidiary of Westrex Corp., died suddenly in Mexico City on June 2, at the age of 53.

He was a native of Chile. He completed his engineering studies at the Escuela de Artes y Oficios, Santiago, Chile, in 1920, and was associated with the Chilean State Railways for eight years and with Paramount Films in Chile for two years.

He joined the Westrex organization in Chile as an engineer in 1930 and he was made operating manager for Westrex in Chile in 1936, a position which he held until 1945 when he was appointed manager for Westrex in Cuba. Later that year he went to Venezuela as Westrex's manager. He became the Westrex Mexico manager seven years ago. He had been a member of the Society for the past ten years.

## section reports

**The Atlantic Coast Section** monthly meeting was held on May 17 in the Moderne Room of the Belmont Plaza Hotel. Ralph M. Evans of the Color Technology Div., Eastman Kodak Co., presented his informative and interesting paper and demonstrations on "Color and Brightness in Projected Color Pictures." The technical program was attended by over 150 Society members and guests.

Prior to the formal program, there was a good turnout for the dinner get-together in the Belmont Plaza's Glass Hat. Response to these informal dinner sessions has been gratifying to the Section officers.—*V. M. Salter*, Section Manager, % E. I. du Pont de Nemours & Co., 248 W. 18 St., New York 11.

**The Atlantic Coast Section** had their sixth program meeting for the calendar year 1955 on June 28. This meeting consisted of an open house at the Kodak Processing Laboratory at Fair Lawn, N.J. In spite of warm summer weather, and the fact that the processing station is some distance outside


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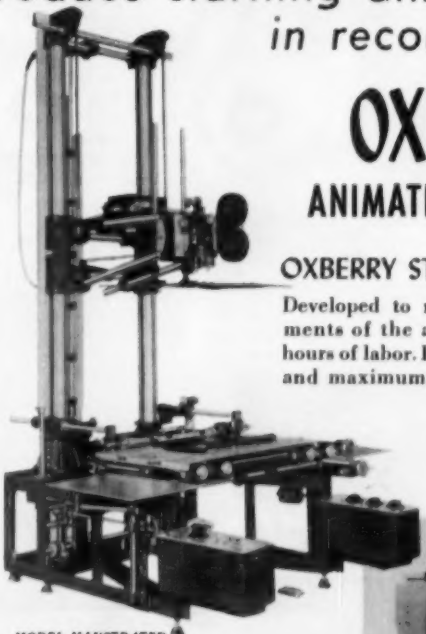

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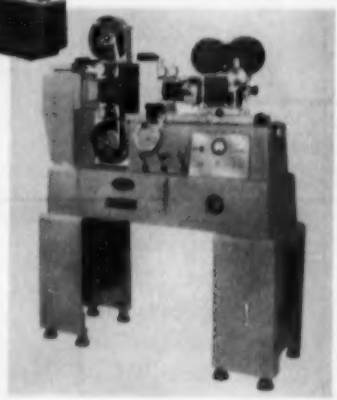

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of New York City, a crowd which far exceeded the expectations appeared for this tour. Approximately 300 members and guests arrived for the conducted tour through the laboratory. About 60 members and guests took advantage of the chartered buses which had been arranged to provide transportation to Fair Lawn and return to New York City. This Kodak processing plant which handles only 35mm Kodachrome film was designed to allow room and facilities for other processes in the future. The plant was in operation during the visit of the Society, but one of the processing machines was in white light so that it could be examined along with the other equipment and operations of the plant.

Guides selected from the supervisory staff of the laboratory accompanied each group of about ten members or guests and explained the various operations and described the equipment concerned. An opportunity was provided to see everything from film receiving to shipping and from chemical mixing to chemical recovery. After the tour was completed, the processing laboratory provided refreshments in the plant cafeteria.

Based on the response to this meeting, as expressed to the section officers personally at the meeting and the write-ups on the pocket cards which were distributed, the conclusion is that tours of processing plants and other commercial facilities within the motion-picture and television industry have a wide appeal and are highly popular with our membership.—*George H. Gordon*, Secretary-Treasurer, c/o Eastman Kodak Co., 342 Madison Ave., New York 17.

**The Pacific Coast Section** met on May 24 at RKO-Pathe Studios in Hollywood.

An entertaining cartoon film supplied through the courtesy of Herbert Klynn of United Productions of America opened the meeting. The technical program consisted of three related papers pertaining to photographic definition, all of which had created a great deal of interest when presented at the recent Convention in Chicago. These papers were: "The Role of Resolving Power and Acutance in Photographic Definition" by G. C. Higgins and R. N. Wolfe; "The Effect on Definition of the Stage at Which Reduction Is Performed in Reduction-Printing Processes" by G. C. Higgins, R. L. Lamberts and R. A. Purdy; and "Depth of Field and Perspective Considerations in Wide-Screen Cinematography" by R. N. Wolfe and F. H. Perrin. The authors of these papers are at Eastman Kodak Co., Rochester, N.Y. Bob Hufford, Eastman Kodak Co., Hollywood, Arrangements Chairman for the Pacific Coast Section, coordinated the procurement of the accompanying slides and demonstration films which were also in demand for use at other SMPTE section meetings this month.

The Pacific Coast Section greatly appreciated the courtesy of the RKO-Pathe Studio management in providing a large sound stage and the associated screen and projection facilities for this meeting. John Aalberg, Director of Sound at RKO-Pathe Studios, very kindly handled all of the studio arrangements. Approximately 250 members and guests of the Society attended this meeting.—*E. W. Templin*, Secretary-Treasurer, % Westrex Corp., 6601 Romaine St., Hollywood 38.

The regular June technical session of the **Pacific Coast Section** was held at Twentieth Century-Fox Studios on the evening of Tuesday, June 21. About 140 persons attended, the number necessarily being limited on a pre-reservation basis to the accommodations that were available in the studio review room where the meeting was held.

Everett Baker, Head of Documentary Film Branch, Technical Information Department, Naval Ordnance Test Station, Pasadena, presented a very interesting color film prepared by his department covering the development of the 2.75-in. folding fin aircraft rocket known as Mighty Mouse. The film, *A Problem in Precision*, was prepared to show the importance of precision in the manufacture of the components used in this rocket, and was intended for showing to the workers and technicians having a part in its manufacture. Mr. Baker not only directed the production, but also played a very prominent part in the picture. He also presented David Bowen, who was responsible for all technical phases of the production.

John G. Frayne, President of the SMPTE, discussed the new Educational Program proposed by the Society. He emphasized the need for the industry to provide on-the-job training for those currently employed, as well as to provide for new highly trained personnel to meet the technological advances in the industry. He pointed out that although there had been a great influx of qualified engineers into the industry at the time of the introduction of sound, very little new talent has come into the industry within recent years. He stressed, therefore, the encouragement of training in qualified colleges and universities for those planning to make careers in the motion-picture industry. He also pointed out that technology advances within the next five years might even make the situation, as far as technical talent is concerned, more serious than it is at the present time. A brief report was was also given by Lorin Grignon, Chairman of the Subcommittee on Training of Sound Technicians. This Subcommittee is quite active in formulating a program in this direction.

Sol Halprin, Executive-Director of Photography at Twentieth Century-Fox, discussed the new CinemaScope combination anamorphic series of lenses which are now available and being used on current Twentieth Century-Fox productions. Selections from several new productions made with these lenses were shown. The screening strikingly demonstrated the excellent definition and photographic quality which is obtained.

The Society greatly appreciated the courtesy of Twentieth Century-Fox, and in particular of Sidney Rogell, Executive Production Manager, for providing Darryl Zanuck's review room for this meeting.—*E. W. Templin*, Secretary-Treasurer, % Westrex Corp., 6601 Romaine St., Hollywood 38.


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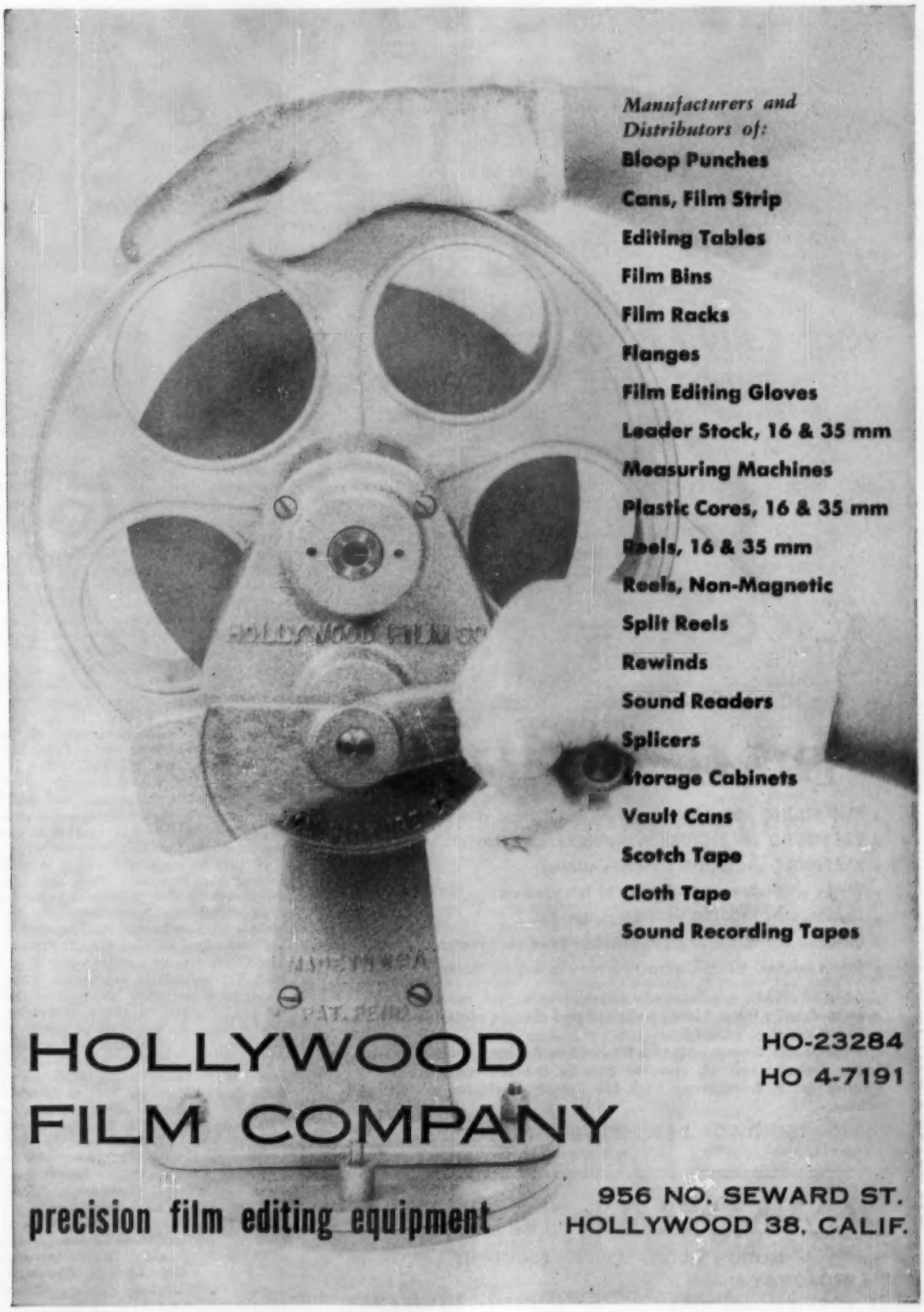
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**Louis Philippe Clerc,** pioneer and leader in the photographic art, will celebrate his 80th birthday on August 20. His influence and work have dominated the whole field of photography in France for more than fifty years and have extended far beyond the borders of his native land. A popular, familiar figure at every International Congress of Photography since the meeting in Paris in July 1900, Mr. Clerc has labored intensively and unceasingly for the advancement of photography throughout the world. His contributions have been particularly outstanding in the fields of graphic arts, color photography, aerial photography, photographic chemistry and scientific applications of photography.

At 14 years of age, he was already an expert amateur photographer and he noted that documentation on photography in France was very poor. As a result of this observation, he spent part of his holidays every year studying foreign publications. As early as 1896 he began to contribute to various photographic journals in France and to publish summaries of foreign works. Among others he published French translations of the principal articles by Hurter and Driffield, the pioneers in sensitometry, who at that time were unknown in France.

As a teacher of chemistry and photography, Mr. Clerc has had a long and distinguished career. He taught analytical chemistry at the Paris University from 1898 to 1937. He founded in Paris in 1926 and directed for many years a Technical School

of Photography and Cinematography. He also taught physics and chemistry applied to the graphic arts at the Ecole Municipale Estienne in Paris. Finally he was asked to teach photographic photometry at the Paris Institute of Optics. He took an active part in the meeting of the International Congress of Photography in Paris in 1900 and has served for many years as the permanent secretary for France, 5th, 6th and 9th editing the proceedings of the International Congresses of Photography.

After a few months service in the infantry in the first World War, he was asked to direct one section of aerial photography. The results were reported in the 24th Traill Taylor Memorial Lecture of the Royal Photographic Society of Great Britain. (*Photo. J., 61:* 382, Nov. 1921). He discussed aerial photogrammetry, rectification of aerial photographs, and aerial stereoscopy. For his services in aerial photography during the war, 1914–1918, he was decorated with the Croix de guerre.

In 1921 he began publication in each issue of *Revue Française de Photographie* of a supplement entitled "Science et Industries Photographiques," which eventually became a separate journal. This publication has been edited for more than 30 years by Mr. Clerc, without a collaborator of any kind. This formidable task can be appreciated somewhat when it is realized that the work requires an ability to translate several languages and a sound knowledge of many fields of photographic science.

A few of the important positions held by him besides his editorship of *Science et Industries Photographiques*, 1921 to date, are as follows: Co-director of the magazine *La Photographie*, 1896–1901; Secretary to the editorial staff, *La Photographie Française*, 1901–1904; Editor-in-chief, *Les Procédés Photomécaniques* since 1901; Editor-in-chief, *Revue des Sciences Photographiques* from 1914 to date; Collaborator for: *Grand Encyclopédie; Dictionnaire de Chimie* by Wurtz (2nd Suppl.); *Dictionnaire Larousse; Journal de Physique; Bulletin de la Société Française de Photographie et Cinématographie; Photographic Journal* (RPS-London); *Camera Obscura* (Amsterdam); etc.


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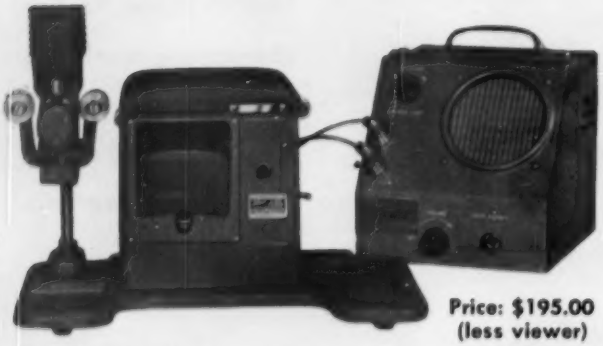

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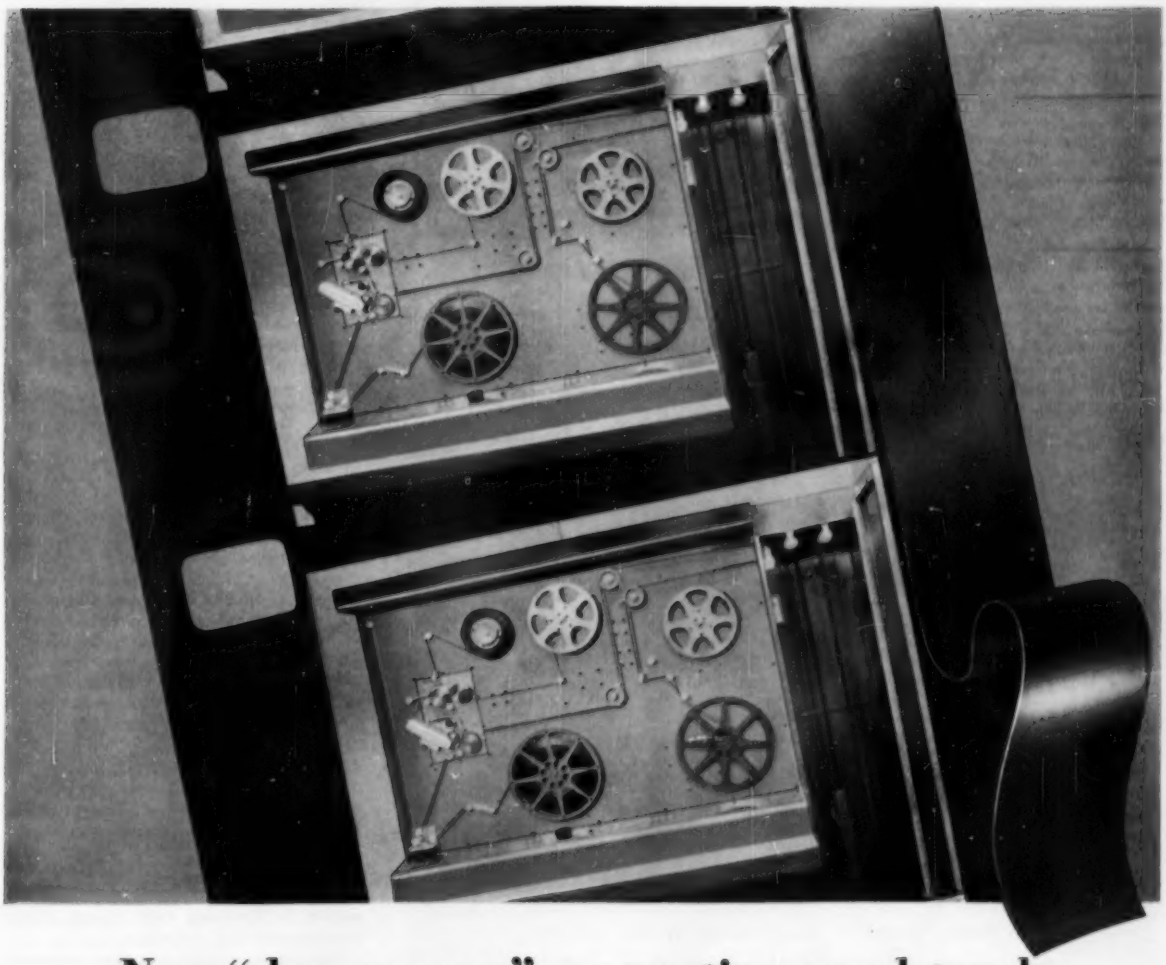

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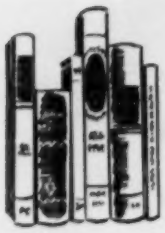
In the past fifty years Mr. Clerc has written no less than twenty books on several different fields of photography. Some of these books have been translated into several languages. He is probably best known for his authoritative work, *La Technique Photographique*, first published in two volumes in 1926 and since appearing in five other editions, three of which were translated into English in 1930, 1937 and 1954. He has published extensively in many photographic magazines over a long period of years.

It has been the privilege of very few men to have contributed so effectively and lastingly in as many fields of photographic science during their lifetime as has Louis Philippe Clerc. In so doing, he has honored his country and he continues to labor faithfully for the advancement of photography throughout the world.—*Glenn E. Matthews (adapted from PSA Journal, p. 581, Oct. 1952).*



# books reviewed

## TV Stations

By Walter L. Duschinsky. Published (1954) as part of the Progressive Architecture Library by the Reinhold Publishing Co., 430 Park Ave., New York 22. 136 pp., incl. 5 appendices, bibliography, glossary of TV terms and index. Numerous illus. 9 × 12 in., Price $12.00.

The author has been responsible for the basic planning and layout of the broadcasting and telecasting facilities for the United Nations' Building in New York and he has been associated with several architectural firms as well as a management consultant firm.

This book is intended to serve as reference material for architects, engineers, TV station managers and program production men. It contains a great deal of information which will be of interest to persons who are inexperienced in TV broadcasting or to students who are studying it.

The material is well organized and indexed and is presented in three parts.

Part I devotes 35 pp. to the "Master Plan" for a TV station and a method of making an analysis of a future station's requirements. It does not purport to explain how a neophyte should accomplish this complex task, but it does make a strong point that professional advice is desirable during the initial planning stages. It advocates a number of surveys and studies covering such factors as audience potential, revenue expected, time factors, transmitter site selection, and operating expense. It also describes space utilization and traffic flow in studio buildings and relationships between various TV departments.

An organization chart is shown for a very large TV station or a network operation. This chart will be awesome to the prospective small market TV station owner, but it serves a purpose in describing a complex organization.

A brief description is given to TV technical equipment and its usage and this section is illustrated with typical photographs taken in TV stations.

The Summary of this section contains a number of helpful suggestions for reducing costs of operation by improved planning. It also reviews a number of factors of UHF propagation.

Part II deals with general information relating to personnel functions and job descriptions, factors affecting employees' morale, market surveys, TV site and facilities, antenna towers, TV coverage, programming, audience ratings, and network affiliation and its advantages.

It also deals briefly with film facilities, and production requirements for live talent programs, the advantages of various control-room arrangements, and requirements for large live talent studios.

Studio lighting considerations are given only very brief mention, as are acoustical treatment, sound isolation and the reduction of noise in ventilating systems. This is unfortunate in this reviewer's opinion, since it has been his experience that architects and their engineers as a whole are not well informed on these subjects.

One of the best parts of this section of the book deals with the factors relating to UHF vs. VHF competition in the same market. The author's statements have been proven by the experiences of UHF failures in mixed TV markets.

Appendix 1 is a typical example of "Master Plan" study for a new UHF station. It will be helpful reading for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persons who contemplate being involved in a competitive FCC hearing. It also presents the UHF vs. VHF factors in a clear and concise manner.

Appendix 2 is principally excerpts from the NARTB film manual, and it provides conclusions which are based upon operating stations' data. Appendix 3 relates to transmitter and antenna combinations for various effective radiated power. Appendix 4 is brief mention of color TV requirements. This is excusable since the book was written prior to when color TV equipment was available. Appendix 5 is a union directory. A short bibliography and a glossary of terms used in television complete the book.

The author of this book has attempted to cover a tremendous field within 136 pp. and he has done the job creditably. The book will be valuable to anyone embarking on a career in television broadcasting or its related fields. It fills a need for a management guide in TV station planning and it will be useful for an architect's reference file.—*R. A. Isberg*, Consulting TV Engineer, 2001 Barbara Dr., Palo Alto, Calif.

## Proceedings of the National Electronics Conference—Vol. 10

Published (1955) by National Electronics Conference, 84 E. Randolph St., Chicago, Ill. 808 pp. incl. numerous charts, diagrams and tables, + 24 pp. cumulative index, + 20 pp. subject and author index. 6 × 9 in. Price $5.00

The National Electronics Conference has been held annually since 1944 with the exception of one break in 1945. Volume 10 of the Conference Proceedings records the complete texts of all papers, technical and otherwise, given at the 1954 conference. This special anniversary volume contains a complete index by authors and subjects of all prior Proceedings, and several commemorative papers relating the historical background of the Conference.

In addition to the historical papers, and certain specialized papers relating to management, there are 82 technical papers covering the gamut from antennas to television. The major emphasis is on military applications, with 25 of the papers directly sponsored by military contracts or establishments. The treatment is generally at a highly theoretical level — ten of the papers were sponsored by colleges and universities; seven others are parts of Ph.D. theses.

Only three of the papers are devoted specifically to television. The topics covered are "Home Design Considerations for Triode System of TV Picture Tube Guns," "A Linear Color Television Receiver" and "Cathode Ray Tube Deflection System Using Transistors." The last is of some specialized interest because the advantages and limitations of transitors are described, when used in this application. A number of the other papers provide information which could be useful to the television engineer. Among these might be noted several papers, on the use of Stripline components as microwave transmission elements, one on "Modulation Wideband Splatter of VHF and UHF Transmitters," and one on an "Electronic Filter for Very High Voltage D-C Power Supplies". (This last describes an interesting circuit for reducing the amount of capacity necessary to obtain a specific ripple factor, resulting in an overall cost and volume saving.)

The heterogeneous nature of the material in this volume makes it impossible to do justice to any specific subject in the course of a brief review, or even to list all subject categories. This book is neither a complete general reference text, nor an exhaustively complete treatment of any one topic. Still in combination with the previous volumes of the series, it makes an excellent source of current information on a host of subjects. The typography is good, and the illustrations are clear and well placed relative to the text. Variations in notation and terminology are surprisingly few, considering the large number of authors involved.—*Sol Sherr*, General Precision Laboratory Inc., Pleasantville, N.Y.

## Graphics in Engineering and Science

By A. S. Levens. Published (1954) John Wiley and Sons, 440 Fourth Ave., New York 16. 696 pp. 817 illus. 6½ × 9¼ in. Price $7.00

This text book, intended for use of engineering and science students in college, could also serve as a reference book in post-college years. It deals with the graphical presentation of ideas, objects and problems in many branches of science, both applied and theoretical.


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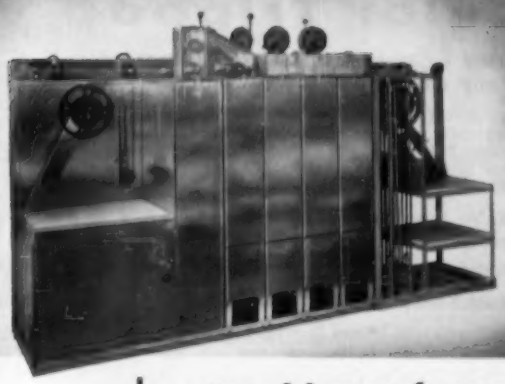

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Part I presents the principles and applications of graphical projection. Although titled "Orthogonal," it covers oblique and perspective projection, as well as the various forms of what is more commonly called orthographic projection. Multiplanar projection, the standard method used on engineering drawings, is analyzed and extensively illustrated. Special applications such as developments, intersections, angle problems, and the so-called pictorial types, isometric, dimetric and trimetric are treated in separate chapters.

Part 2, on "Technical Drawing Practice," contains conventional chapters on sectional views, threads and fasteners, gears, cams and dimensioning practices. There is, in addition, some material not found in older manuals. The extensive work done in the field of lock-nuts and lockwashers is partially illustrated and discussed. Also, a little more than the usual emphasis is placed on the necessity for correct dimensioning and tolerancing of drawings, a very weak link in the training of most engineers and draftsmen. The precepts of this section however are not well followed in other parts of the book. The gear drawings, for example, do not control the accuracy of the gears by showing proper tolerances. Much of the material on gears, cams and locking devices could be left out, since it is more properly a part of books on machine elements. It is somewhat inconsistent to include design data on gears and cams but not on bearings, linkages, pulleys and so on.

Part 3, "Graphical Solutions and Computations," is unique. Although some of the material can be found even in the old classic, French's *Engineering Drawing*, it is unusual to find so much space allotted to the application of graphics in mathematical, engineering, and even anatomical problems. The author aptly points out that some problems may be solved with sufficient accuracy for design purposes and much more quickly than by analytical methods. In fact, the analytical solution of some problems, such as determining the amount of involute interference in a defective gear mesh, would be so involved as to be completely impractical.

The book as a whole tends to be somewhat bulky. Although it is not represented as a text for the professional draftsman, it contains almost everything that may be found in standard text books on drafting, even to the usual lengthy appendix. In fact, the 166 pp. of appendixes in this book might even be a record. The inclusion of so much conventional drafting material apparently evolves from the author's admission that even an engineer should have "a reasonable proficiency" in the use of drafting instruments. His haste to add the thought that greater emphasis should be placed on the development of freehand sketching reminds the writer of the advice recently given the freshman class at an Eastern engineering college to avoid drafting jobs lest they be "stuck on the board." The "board" is apparently becoming the sign of a lower caste, and not the indispensiable tool of the design engineer. In spite of Professor Levens' plea for more extensive use of graphics in engineering and science, he gives the impression that he also believes that although the engineer should be able to "talk with a pencil" he should do most of his thinking with a slide rule.

In spite of the book's size, there are two noteworthy omissions, rather surprising considering the broad scope of the title. First, no mention is made of the extensive use of graphical symbols in electronic or structural engineering nor is any space given to the drafting techniques of the drawings peculiar to these fields. Secondly, there is no explanation of the function or technique of the design layout, which is the basis for any set of manufacturing drawings. From the author's remarks on freehand sketching, and the exercises under dimensioning practice, the engineer's job appears to be that of supplying fully dimensioned pictorial sketches to the draftsman for redrafting into multiview orthographic form. The interesting graphical process by which the shape, size and number of parts are developed by the designer or design engineer in the layout is not treated. On Professor Levens' side, however, it should be noted that most texts on engineering drawing, for some unknown reason, also omit any discussion of the design layout.—*John C. Duffy*, General Precision Laboratory Inc., Pleasantville, N.Y.

### Film Manual 1955

Published (1955) by National Association of Radio and Television Broadcasters, 1771 N St., N.W., Washington, D.C. 36 pp. 8½ × 11 in. Paper covered. Available to those not eligible for NARTB membership at $1 a copy.

*Film Manual 1955* is the second of the annual studies published by the National Association of Radio and Television Broadcasters on film use in television stations. The expressed aim of these Manuals is to pass on to all stations, both new and old, those procedural patterns which have been developed by experience in the field of station film operations; they represent a highly practical guide for station management.

The first part of the present Manual gives comparative data collected from over 100 stations on film programming hours and costs. It is noteworthy that this survey supports last year's findings as to the importance of film programming as an integral part of all local programming — the report indicates 29 hr and 24 min of local film programming as compared with 18 hr and 26 min of local live programming.

In the second part five film department case histories are presented, providing information on film policies and procedures developed by specific local stations in various geographic areas. Emphasis is on television film operations in the relatively smaller markets. Each case history covers film purchasing, personnel, film equipment, film facilities, operational procedure and programming, specifications and engineering.

The last section of the Manual consists of a feature article on "Television Operation Procedures" supplied through this Society, at the request of NARTB, by SMPTE member Louis J. Climent.


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## Closed Circuit Data Book

By Leonard Spinrad. Published (1955) by Leonard Spinrad, 511 E. 20 St., New York 10. 72 pp. 8½ × 11 in. Paper covered. Price $10.00.

A growing industry which now has behind it well over 200 closed-circuit telecasts is the basis for the data in Mr. Spinrad's compilation which includes listing of the personnel of every active closed-circuit production company, details of all available closed-circuit projection equipment and a full directory covering this TV medium such as rates, available cities for both black-and-white and color, labor unions and descriptions of the various types of closed-circuit operations. There is a review of the position of the government regarding channels for closed-circuit telecasting, which is of special interest in connection with current TV special-channel applications pending before the Federal Communications Commission.

The chronology of telecasts is indexed by subject, arranged by date and also indexed by sponsor's and producer's organization names. The number of closed-circuit telecasts is reported as doubling from year to year making a future industry for which this Data Book is a good introduction.—*V.A.*


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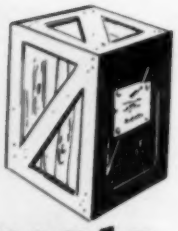
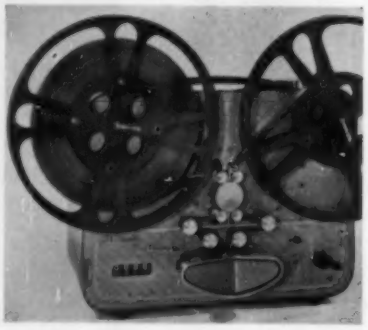


# new products (and developments)

**Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.**



**The Model S6 system** is a new line of professional magnetic film equipment recently announced by Stancil-Hoffman Corp., 921 North Highland Ave., Hollywood 38. A chief aim of the new design was to make portable recording systems that can be operated from normal a-c sources or batteries.

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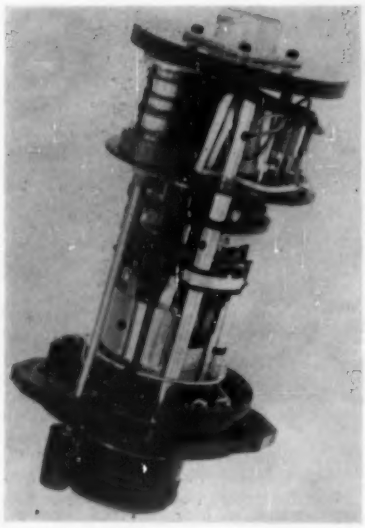
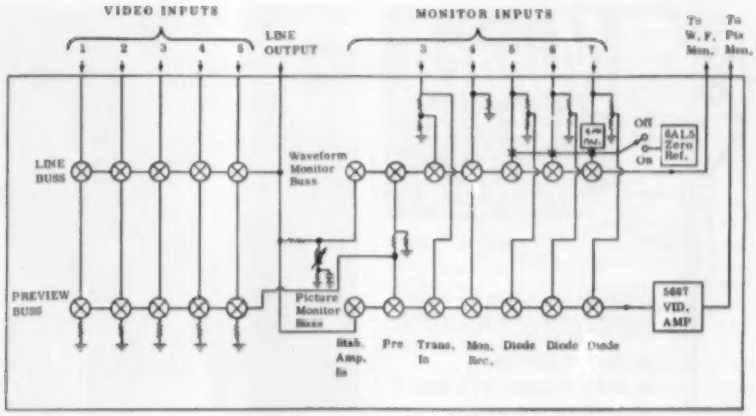
The S6 system is designed about a 24-v battery supply because of the practical availability of such. A full line of inverters and converters is reported available for any camera and recorder combination. There are also may accessories for use with the system which is for 16mm or 17½mm film.

**The Intervalometer** has been designed to enable the flight engineer to select a basic rate for pulsing cameras which record flight data, with either additional single-frame operation or pre-set cine rates. Called the Gordent 15, this model provides a preset pulse duration of from 100 msec to 1 sec, and a normal pulse frequency of from one pulse each ½ sec to one pulse every 60 sec, in steps of ½ sec. When a pulsation from a



single-frame or cine operation occurs at the same time as a pulsation from the basic-rate function of the unit, an electronic bypass prevents feedback. Thus, the cine or single-frame functions are in addition to, rather than instead of, the basic pulse rate. The unit was developed by Gordon Enterprises, 5362 North Cahuenga Blvd., North Hollywood, Calif., in cooperation with the Instruments Div., Air Force Flight Test Center, Air Research and Development Cmd., Edwards AFB, Calif.




**The Type 5304-A Video Switch Unit** is a combined program and monitor switching device designed primarily for television transmitter locations or small studio control-room operations. This inexpensive unit is designed to provide facilities for switching any one of five input signals to a single output buss. In addition, separate picture and waveform monitor outputs permit previewing of any of the five input signals, the output signal or any of five other monitor input signals (see diagram).

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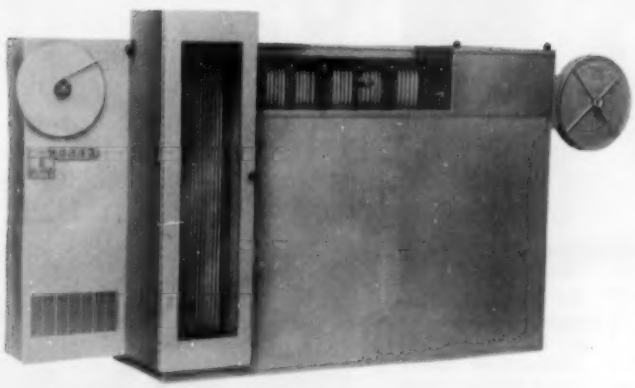

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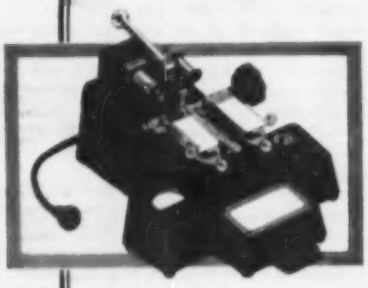

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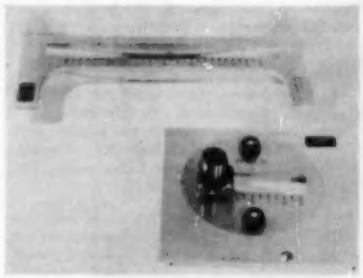
**Photographing and studying traffic** has been instituted by the New Hampshire Dept. of Public Works and Highways, using an industrial television camera as shown above operated from a bridge, with the results shown on a monitor or on a TV screen in the Dept's administration building several miles away. The camera and monitor are those of General Precision Laboratory Inc., Pleasantville, N.Y., and the microwave link equipment is that of Raytheon Mfg. Co., Waltham 54, Mass. The New Hampshire department has also demonstrated an automatic toll collector and a radar-operated warning signal which lights up suddenly when a speeding car approaches. "Slow down!" it says, "You are speeding!" This sign is activated by the vehicle itself.

**The FL-1001 TV Projector** is a product of the Fleetwood Corp., 1037 Custer Dr., Toledo 12, Ohio. Designed for closed-circuit TV conferences and demonstrations, as well as for use in smaller theaters and hotels, it projects a picture large enough to be viewed by several hundred people — up to 9 × 12 ft. Designed to receive all channels, the projector operates on 110-v a-c. Overall size of the unit is 2 ft wide, 3 ft deep and 4 ft high. It weighs about 400 lb.

A mobile audio-visual truck is another new unit designed by Fleetwood Corp. primarily for roadshow operators in this country and for foreign government use.

**The new Eastman 16mm Continuous Projector, Model 300,** has been designed to improve the quality of color television film programs through providing a continuous, uniformly illustrated image. Newly designed, except for the sound-head which is that of the Eastman Model 25 Projector, special features include an *f*/1.6 optical system and automatic compensation for film shrinkage by means of a special sprocket. The optical system has a collimating lens of 25-in. focal length; tilting, rotating mirrors to compensate for film travel; and a 3-in. *f*/1.6 objective lens focused on the film. A flying-spot television tube is used as the light source. A full technical description appeared in the June *Journal*, and further information about it is available from Motion Picture Sales Dept., Eastman Kodak Co., Rochester 4, N.Y.



**The Focalscope** is a new instrument for checking aerial camera focus and lens collimation developed by Gordon Enterprises, 5362 N. Cahuenga Blvd., North Hollywood, Calif., under contract with the U.S. Air Force, Gentile Air Force Depot, Dayton, Ohio. The instrument can be used by the camera repair technician when making installations, and the aerial camera man during flight may check the accuracy of the focus to insure sharp pictures, since both altitude and temperature changes may affect lens focus. The unit contains a low-powered microscope on which verniers are mounted and it functions like a portable optical bench. Used as an autocollimator it employs a self-contained light source which is projected from the instrument though the camera body and lens and reflected back into the eyepiece, the lens acting as its own collimator. The instrument can be adapted to use on both 9 × 9 in. and 9 × 18 in. film sizes.

**The Dual Reader** is a new equipment for 16mm film editing, consisting of an optical sound reproduction unit, a combination amplifier-speaker, and a baseplate to which any 16mm motion-picture viewer can be added and used with sound. The soundhead can be adjusted so that the picture and sound are separated by exactly 26 frames for synchronization, and can be positioned for both single- and double-track systems. The optical slit with prefocused exciter lamp socket will read either variable area or density track. It has a 4-w amplifier and built-in Alnico speaker. A separate exciter lamp rheostat control is incorporated to permit varying the intensity for hi-fidelity sound. The equipment operates on 110–120 v, 60 cycles a-c, is priced at $195.00, with descriptive literature available from The Camera Mart, 1845 Broadway, New York 23.

**Cine-Kodak Tri-X C-P Reversal Film** is a new product recently released by Eastman Kodak Co., with information from its Editorial Service Bureau, 343 State St., Rochester 4, N.Y. The high-speed Kodak Tri-X emulsion on 16mm reversal film, allowing a daylight exposure index of 200, with a tungsten index of 160, makes it suitable for relatively unfavorable lighting conditions. Processing will be done by the purchaser or through independent 16mm processing laboratories. It will withstand somewhat higher processing temperatures than Kodak Super-XX C-P Reversal Film and is reported to possess sufficient exposure and development latitude to permit its use at speeds higher than its normally rated speed under some circumstances. With only minor sacrifices in speed and graininess, the film may also be used to yield negative images.

Although the film is very sensitive to light, it can be used in a camera with fixed shutter speeds for bright sunlit scenes by placing a filter over the camera lens. It is available in 100- and 200-ft spools, and in 400-ft rolls for darkroom loading, either double perforated or perforated one side. It is also supplied on special order spooled for the Kodak High-Speed Camera or 16mm Fastax Camera. Price of the 100-ft roll on camera spool, without processing, is $4.85.

**Equalizers and Wave Filters** is Catalog 12-E of 16 solid pages giving specifications, characteristics and case studies exemplifying applications of some 19 filters, equalizers and kits. It is available from Cinema Engineering Co., 1100 Chestnut St., Burbank, Calif.


COLOR TEST FILMS AND SLIDES FOR TELEVISION STATIONS

SMPTE now has available 35mm and 16mm color television test films and slides designed for TV station use under specifications set up by the SMPTE Television Committee—representing the quality of color material obtainable from Ansco, Technicolor and Eastman prints.

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# employment service

*These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.*

## Positions Wanted

**Theater Engineering Manager.** Seeking position with large theater circuit or equipment manufacturer. Can assume all responsibility involved in planning, procurement, installation and service of sound and projection equipment; also stage, seating, air conditioning and heating, construction, maintenance entire physical theater and real estate properties. Sales and export experience in High Fidelity. B.S. in E.E. Member SMPTE and licensed professional engineer State of N.J. Over 20 yr experience. C. J. Bachman, 111 Halsted St., E. Orange, N.J.

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**16mm Cameraman.** 15 yr experience; age 41. Last 7 yr as head cinematographer in medical college shooting color exclusively; editing and some animation, also all-round still and lab work, black-and-white and color. Seeking permanent position; complete résumé from: Robert A. Leonard, 2100 10th Ave. South, Birmingham 5, Ala.

**TV Closed Loop Development.** Personal equipment and services available for experimental work on closed loop camera chains and 16mm film projection TV systems. Complete camera chain (using 5820 Image Orthicon) including timing generator, RETMA sync generator, line amps, regulated supplies, slide and 16mm, S.O.F. modified projectors, slide and film, standards and pix monitor. All composite and pulse outputs meet precise RETMA standards. Actively engaged in the art since 1936 with pioneer company, well grounded in compatible color TV techniques. Desire to become associated with small but virile laboratory where the above equipments, solid know-how and can-do will be recognized and remunerated accordingly. Harold A. Lockwood, c/o State Hospital, Logansport, Ind.

**Television Floor Manager.** Young married man desires TV floor position with aggressive station. Recently completed film seminar at New School (New York). Show business background; acting, directing. Will locate anywhere. Write: Joseph R. Masefield, 15 Berkeley Place, Brooklyn 17, N.Y.

## Positions Available

**Audio Laboratory Engineering Assistant.** Will set up, operate and maintain audio equipment in Audio Division of major consumer testing organization; will construct auxiliary equipment as required; will assist division head and others in testing audio equipment sold to public. Required—degree in electrical engineering or equivalent experience; also 3–4 yr experience in audio equipment operation and maintenance; some familiarity with theory and mathematics of audio electronics and acoustics. Salary $100 up depending on individual. Send résumé to Personnel Director, Consumer Reports, 17 Union Sq. West, New York 3.

**Partnership** available to experienced motion-picture technician in small film concern. Desire and ability to be "own boss" imperative. Requisites: Recording, editing, camera, special effects, animation skills—initiative, drive, intelligence, flexibility and inventiveness. Sales ability and administrative aptitude essential. Resume in letter form stating pertinent facts and full expression of personal and vocational objectives will be accorded strict confidence. Graphic Films, 104 West 43 St., New York 36.

**Film Technicians.** Motion-picture laboratory experience required—top pay offered to timers, developers, printers, negative and positive workers, cleaners, projection inspectors, chemists, machinists. Movielab Film Laboratories, Inc., 619 West 54th St., New York 19.

**Film Editor.** Demonstrated creative and technical ability, minimum 1 yr of editing experience. Work in other phases of motion-picture production helpful, but not necessary. Employment will be with college motion-picture unit engaged in production of educational films for TV and classroom use. Basic starting salary approximately $70 per week, commensurate with ability and experience. Send resume of background and experience to Norman E. C. Naill, Motion Picture-TV Service, Virginia Polytechnic Institute, Blacksburg, Va.

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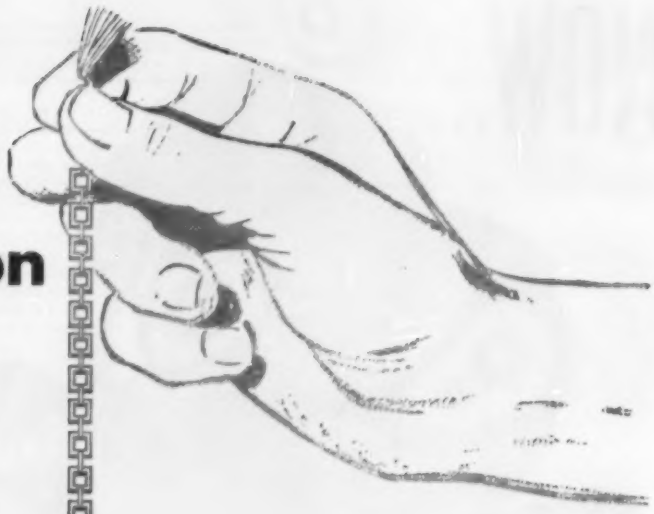

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### Meeting Calendar

Biological Photographic Association, Annual Meeting, Aug. 30–Sept. 2, Wisconsin Hotel, Milwaukee.
American Chemical Society, National Meeting, Sept. 11–16, Minneapolis, Minn.
Illuminating Engineering Society, National Technical Conference, Sept. 12–16, Hotel Statler, Cleveland, Ohio.
Instrument Society of America, Sept. 12–16, Shrine Exposition Hall and Auditorium, Los Angeles.
National Electronics Conference, Oct. 3–5, Hotel Sherman, Chicago.
**78th Semiannual Convention of the SMPTE, Oct. 3–7, Lake Placid Club, Essex County, N.Y.**
American Institute of Electrical Engineers, Fall General Meeting, Oct. 3–7, Morrison Hotel, Chicago.
Photographic Society of America, Oct. 5–8, Sheraton-Plaza Hotel, Boston, Mass.
Optical Society of America, Oct. 6–8, Hotel Wm. Penn, Pittsburgh, Pa.
Theatre Owners of America, Oct. 6–9, Biltmore Hotel, Los Angeles.
Audio Engineering Society, Oct. 12–16, Hotel New Yorker, New York.
American Standards Association, 37th Annual Meeting and Sixth Annual Conference on Standards, Oct. 24–26, Washington, D. C.
American Rocket Society, Nov. 13–18, Chicago.
American Society of Mechanical Engineers, National Meeting, Nov. 13–18, Hotels Congress, Hilton and Blackstone, Chicago.
American Institute of Chemical Engineers, Nov. 27–30, Hotel Statler, Detroit.
Acoustical Society of America, Dec. 15–17, Brown U., Providence, R. I.
Optical Society of America, Apr. 5–7, 1956, Bellevue-Stratford, Philadelphia, Pa.
**79th Semiannual Convention of the SMPTE, including Equipment Exhibit, Apr. 29–May 4, 1956, Hotel Statler, New York.**
**80th Semiannual Convention of the SMPTE, Oct. 7–12, 1956, Ambassador Hotel, Los Angeles.**
Optical Society of America, Oct. 18–20, 1956, Lake Placid Club, Essex Co., N.Y.
Optical Society of America, Mar. 7–9, 1957, Hotel Statler, New York.
**81st Semiannual Convention of the SMPTE, Apr. 28–May 3, 1957, Shoreham Hotel, Washington, D.C.**
**82nd Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 6–11, 1957, Hotel Statler, New York.**
**83d Semiannual Convention of the SMPTE, April 20–26, 1958, Ambassador Hotel, Los Angeles.**
**84th Semiannual Convention of the SMPTE, Oct. 19–24, 1958, Sheraton-Cadillac, Detroit.**
**85th Semiannual Convention of the SMPTE, May 3–8, 1959, Fontainebleau, Miami Beach, Fla.**
**86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–10, 1959, Hotel Statler, New York.**

**SMPTE Officers and Committees:** The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April Journal.

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